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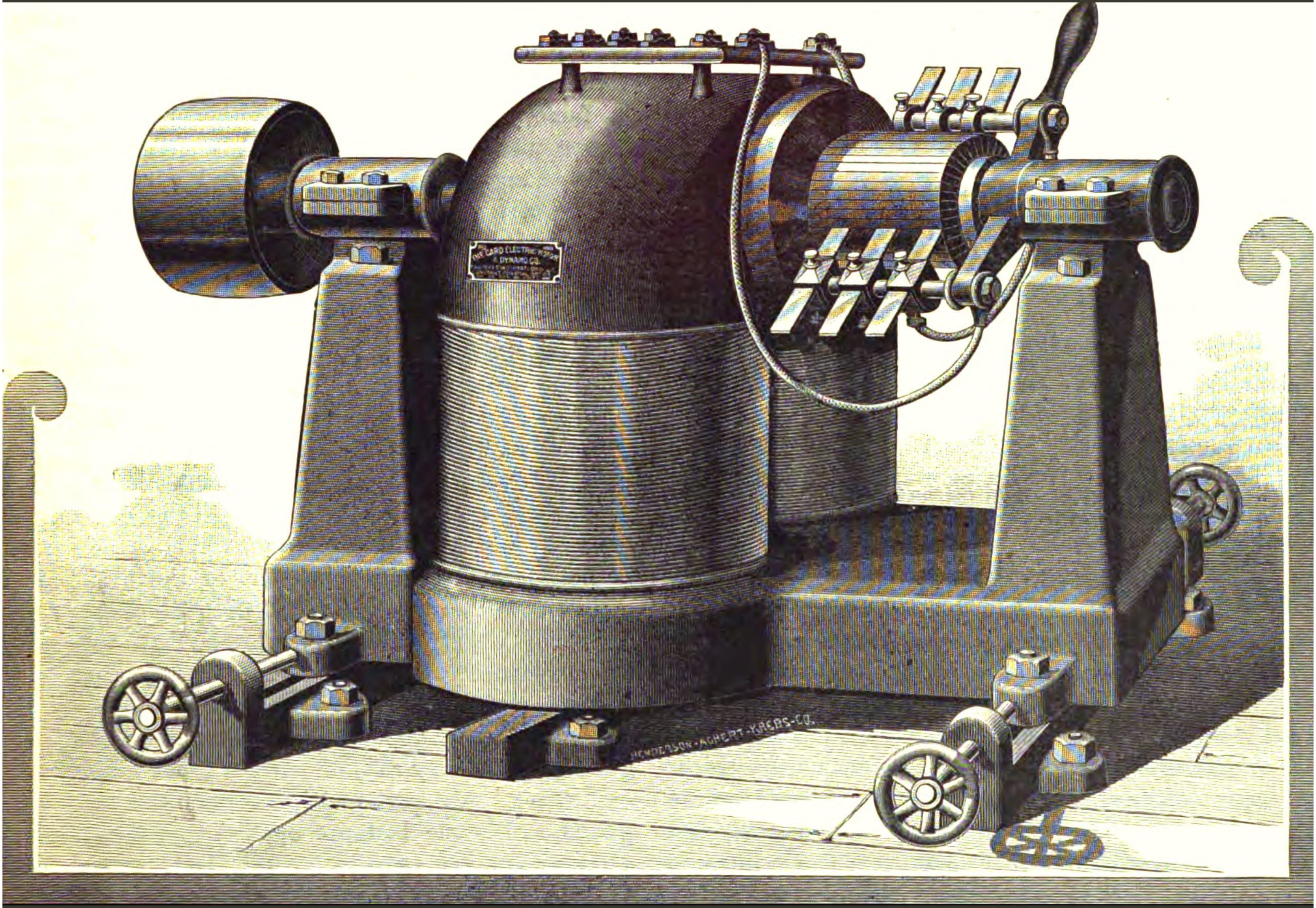
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HE INVENTORS OF THE ELECTRIC MOTOR.—I.

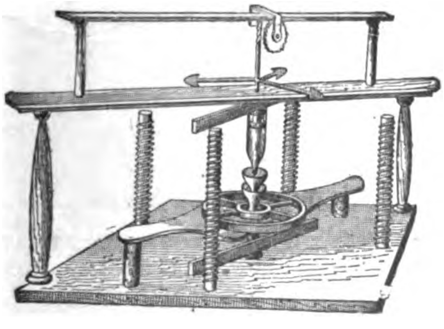
WITH SPECIAL REFERENCE TO THE WORK OF THOMAS DAVENPORT.

BY

Franklin Leonard Pope

> To rightly appreciate a discoverer we should not look at his ork from our time; we should not judge of his work in the full-ess of the light of present knowledge, but in the dim twilight hich alone illuminated him to then unknown—but now well-nown—facts and laws.—ALFRED M. MAYER.

HE electric motor, which but a few brief years ago, was regarded as but little better than a philosopher's plaything, has, with almost startling suddenness, assumed its position as one of the potent factors of modern industrial development. The story of the birth of this great invention has hitherto been given to the world only in part, d even such fragments of its early annals as were once own are now well-nigh forgotten; they linger only in t fading written records, and in the memories of an lier generation, of which the scattered survivors are idly passing from the stage. I have sought, therefore, ile trustworthy evidence is yet accessible, not only from testimony of the few witnesses yet living, but from



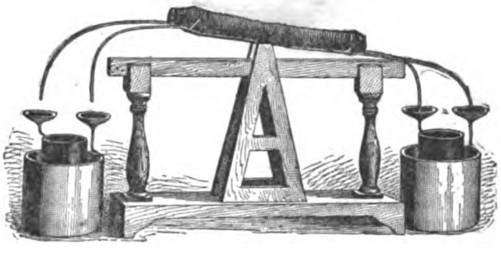
STURGEON'S APPARATUS FOR ELECTRO-MAGNETIC ROTATION.

[*By permission of Charles Scribner's Sons.*]

e time-worn and crumbling pages of contemporaneous nuscripts, to rescue from impending oblivion the true ory of the invention of the electric motor.

It is eminently desirable that we enter upon the field of esearch with a definite conception of what is meant when e speak of the electric motor in the sense of a concrete ganization, in other words as an invention. What, then, t us inquire, is the essence, the fundamental principle, which finds its necessary embodiment in each and every one of the thousands of electric motors which are doing such an important and increasing share of the world's work to-day? The question happily, is not a difficult one to answer. If an expert, skilled in the law of patents, were asked to formulate in legal phraseology a definition which should concisely sum up the new and useful invention embodied in the machine which we know as the electric motor, it might be couched in language something like the following:

The method of producing mechanical power by the application of electro-magnetism, which consists in combining with a suitable source of electricity, two systems of electro-magnets; one system mounted upon a shaft rotating continuously in one direction; the other fixed in relation thereto, and a commutator actuated by the rotation of said shaft, acting to instantly reverse the polarity of one of said systems, when by reason of their mutual attraction, the revolution of the shaft has brought the poles of the moving magnetic system into coincidence with the poles of the fixed sytem.



HENRY'S APPARATUS FOR PRODUCING MOTION BY ELECTRO-MAGNETISM.

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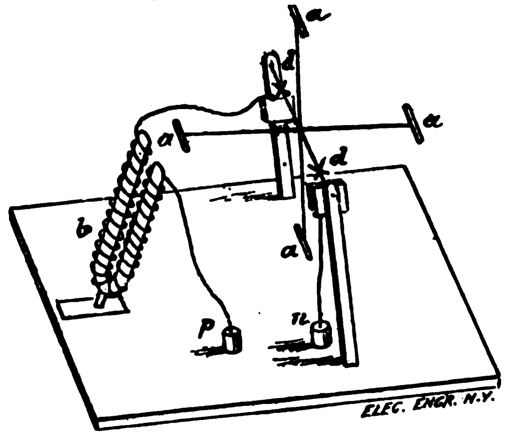
The above definition, formulated in the semblance of a patent claim, will at once be recognized as embracing the essential characteristics of the practical electric motor as we find it at work in the world to-day. On the other hand, it will be observed that the definition excludes certain special organizations, among which may be mentioned the rotary motor having a field induced by the permanent magnetism of steel; the rotary motor in which the intermittent attraction of electro-magnets is exerted upon a succession of non-polarized soft iron armatures arranged upon the periphery of a wheel, and the reciprocating motor in which masses of soft iron are dragged back and forth by the alternately intermittent attraction of electro-magnets or of solenoids. While it may be admitted that these and some other less well-known devices are not without a certain utility in minor and special applications of electric power, nevertheless, in a broad sense, it may be stated without qualification, that the machine of which a definition has just been given, has no less surely proven its right to be regarded as the accepted type of the modern electric motor than has the double-acting cylinder, piston and crank to be regarded as the accepted type of the modern steam engine.

As in the æolipile of Hero of Alexandria we had an example of rotary mechanical motion by the energy of steam before the advent of the double-acting cylinder and crank, so likewise did we have rotary motion by electro-magnetism before the combination of the reversible and the non-reversible electro-magnets in the magnetic engine. But it was not until the unerring inspiration of the master mind of Watt had grasped the true combination, that the world was put in possession of the steam-engine, that mighty agent which was destined to work its industrial regeneration. It has been my endeavor in the present investigation, to determine to whom should be accorded the distinction of being rightfully regarded as the Watt of the electric motor.

Having gained a clear conception of that for which we are to seek, we may proceed to make a critical examination of the history, written and unwritten, of the childhood of the electric motor.



EDMONDSON'S APPARATUS FOR ELECTRO-MAGNETIC ROTATION.
[*From Silliman's Amer. Jour. Science.*]

Faraday, in 1821, demonstrated for the first time the possibility of producing continuous rotary motion by electro-magnetism—not by the electro-magnet, for this instrumentality had yet to be invented—but by the movement of a magnetized needle in a field of force.[1]

Barlow, in 1826, produced his rotating spur-wheel; founded upon the principle of the movement of conductors traversed by electric currents in the field of a permanent magnet.[2] These experiments were repeated with variations by many others. In 1825, Sturgeon[3] discovered the electro-magnet. In his hands, however, it was but a feeble instrumentality; a few turns of wire arranged in a single layer upon a bar of soft iron.[4]

In 1831, Henry's celebrated paper appeared, containing an account of his improvements in the electro-magnet and his experiments therewith.[5] The results which he described literally threw the scientific world of both hemispheres into a paroxysm of amazement; it marked perhaps the most brilliant epoch in the whole history of electro-magnetism. By winding the soft iron of the magnet with many superposed turns of silk-insulated copper wire, this experimenter succeeded in sustaining, solely by the force of magnetic attraction, a mass of iron weighing more than a ton. The accounts of Henry's discoveries, given to the world in a scientific journal of established reputation, were soon in possession of the eminent physicists of the European capitals, and ere long many busy brains were at work, each in an endeavor to add something, however little, to the masterly researches of the American philosopher.

In the same year, 1831, Henry published another paper commencing with these words:

> I have lately succeeded in producing motion in a little machine by a power which I believe has never before been applied in mechanics—by magnetic attraction and repulsion.
>
> Not much importance however is attached to the invention, since the article, in its present state, can only be considered a philosophical toy; although in the progress of discovery and invention it is not impossible that the same principle, or some modification of it on a more extended scale, may hereafter be applied to some useful purpose.[6]

The piece of apparatus referred to by Henry in this communication has been carefully preserved, and now forms one of the most valued treasures of the cabinet of the College of New Jersey, at Princeton. We give an illustration of it, made from a photograph, from which its construction may be readily understood. A straight horizontal electro-magnet, wound with three insulated copper wires, is pivoted at its centre, so as to be capable of a limited vertical reciprocating motion. Just beneath and parallel to this, a permanently magnetized steel bar is fixed in a horizontal position. The ends of the respective wires of the electro-magnet being properly connected, are arranged to alternately dip into mercury cups affixed to the poles of two opposing voltaic cells, and thereby to reverse the direction of the current through the helix at end of each stroke. The contrivance illustrated the principle upon which Henry thought an electro-magnetic machine might be worked out, but having satisfied his scientific curiosity with this demonstration, he, like Faraday,[7] was quite willing

SHOP IN WHICH DAVENPORT AND SMALLEY CONSTRUCTED THEIR FIRST ELECTRIC MOTOR; NOW OCCUPIED AS A DWELLING.
[*From a recent photograph by F. L. Pope.*]

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[1] *Quarterly Jour. Science.* xii, 74. TYNDALL: *Faraday as a Discoverer*, p. 12.

[2] BARLOW: *Essay on Magnetic Attractions, etc.* (2d Ed.) London, 1823, part iii., p. 280.

[3] WILLIAM STURGEON, a celebrated English electrician, born at Whittington, Lancashire, in 1783; was apprenticed in his youth to a shoemaker, but disliking the occupation enlisted in the militia at the age of 19, and two years afterwards in the Royal Artillery. While in this corps he devoted his leisure to scientific investigation and made himself familiar with the leading principles of electricity and magnetism so far as they had then become known to the world. His scientific papers are numerous and of great value, but were sometimes characterized by an amusing exuberance of diction. When writing of his own discovery, the electro-magnet, he was always at his best, as the following extract will bear witness:—

"The superlative intensity of electro-magnets, and the facility and promptitude with which their energies can be brought into play, are qualifications admirably adapted for their introduction into a variety of arrangements in which powerful magnets so essentially operate, and perform a distinguished part in the production of electro magnetic rotations; whilst the versatilities of polarity of which they are susceptible are eminently calculated to give a pleasing diversity in the exhibition of that highly interesting class of phenomena, and lead to the production of others, inimitable by any other means."—*Annals of Electricity*, etc., x., 223.

He was for many years professor of experimental philosophy in the East India Company's military academy at Addiscomb, and in the latter part of his life lecturer on science at the Royal Victoria Gallery, Manchester. Died at Manchester, in December, 1850.

[4] *Trans. of Soc. of Arts*, etc., vol. xliii, pp. 38–52.

[5] Silliman's *Am. Jour. Sci.* xix, 400.

[6] Silliman's *Am. Jour. Sci.* xx, 201.

I never myself attempted to reduce these principles to practice, or to apply any of my discoveries to processes in the arts. My whole attention, exclusive of my duties to the college, was devoted to original scientific investigations, and I left to others, what I considered in a scientific view of subordinate importance, the application of my discoveries to useful purposes in the arts. * * * The only reward I ever expected was the consciousness of advancing science, the pleasure of discovering new truths, and the scientific reputation to which these labors would entitle me.—HENRY: Deposition in Telegraph Case, Morse *v.* O'Reilly.

[7] I have rather however, been desirous of discovering new facts and new relations dependent upon magneto-induction, than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter.—FARADAY: *Experimental Researches.* § 159.

to leave the practical development of the idea in the hands of those who might feel disposed to pursue it.

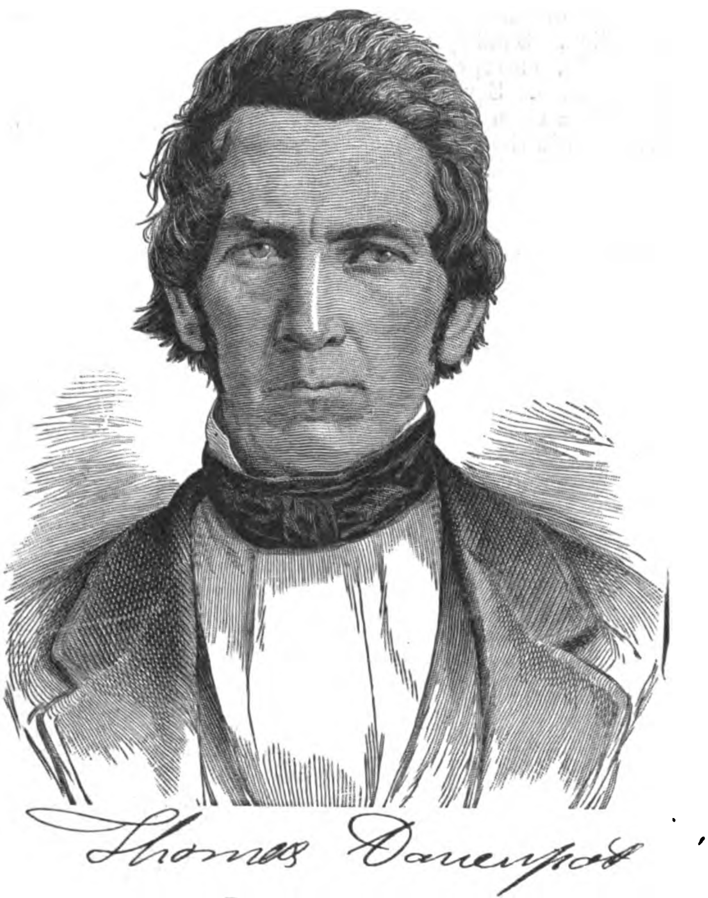
The first published description of an apparatus designed to produce a continuous rotary motion by the agency of an electromagnet is due to T. Edmondson, Jr., of Baltimore, and appeared in 1834.[8]

A fac-simile is given of the illustration accompanying Edmondson's account as published. The apparatus will be seen to consist of a number of neutral soft-iron armatures, mounted upon radial arms affixed to a horizontal shaft. These are successively brought within the sphere of attraction of a stationary electro-magnet, while a commutator is provided by which the magnetizing current is interrupted long enough to permit each armature in turn to pass out of the magnetic field. This appears to be the earliest instance on record of the use of the modern commutator; an elastic contact-spring or brush, pressing against metallic segments fixed upon a revolving shaft.

In 1836, Sturgeon, the inventor of the electro-magnet, published a description of a rotary electro-magnetic engine accompanied by an illustrative drawing, in which he stated that the machine described had been constructed and put in operation as early as the fall of 1832, and had been exhibited before a large audience in London in the spring of 1833.[9]

Sturgeon's apparatus, though usually referred to as the earliest example of an electro-magnetic rotative engine, is in fact little else than a re-arrangement of Ritchie's "revolving magnet," which was described in a paper read by him before the Royal Society, March 21, 1833, and published with an illustrative plate in *Philosophical Transactions*, of that year. The device consisted of a straight electro-magnet, mounted so as to revolve freely upon an upright axis, its poles at each half revolution passing close to the poles of two upright permanent bar-magnets. A mercurial commutator reversed the polarity of the electro-magnet twice in each revolution, as it came opposite the poles of the bar-magnets. Dr. Charles G. Page, then of Salem, Mass., improved this apparatus by the substitution of a metallic commutator, and in this form it became one of the stock pieces of electro-magnetic apparatus in the schools and colleges of America.[10]

The engraving on page 1 is a copy of the illustration given by Sturgeon, from which it will be seen that his machine consisted of two permanently magnetized steel bars turning horizontally upon a vertical axis. The poles of these magnets, as they revolve, are successively attracted by the poles of four upright electro-magnets formed of straight rods of soft iron wound with helices of wire. The details of the commutator are omitted in Sturgeon's drawing, but he explains that the reversal of the polarity of the electro-magnets is effected by permitting the ends of the conducting wires to trail in the segmentally divided vessel of mercury which is seen in the centre of the figure. There is in Sturgeon's description no suggestion of the possibility of substituting electro-magnets for the permanent magnets employed by him.[11]



Thomas Davenport

THOMAS DAVENPORT.

[*From a daguerreotype made in Salisbury, Vt., about* 1850.]

Not long after the publication of the paper of Henry which has been referred to, an attempt was made by parties interested in the Penfield Iron Works at Crown Point, N. Y., to employ magnetism for separating the constituents of pulverized iron ore. A machine was devised, containing a wooden cylinder, the surface of which was armed with a great number of teeth or points of magnetized steel. These were made to revolve continuously through a mass of pulverized ore. The particles of iron were separated from the refuse by adhering to the magnetized teeth, from which they were afterwards brushed off by suitable appliances. In order to charge these magnetic teeth there had been procured, at the suggestion of Professor Amos Eaton, of Troy, from Professor Henry, one of his electro-magnets made of a 1-inch rod, and weighing about 3 pounds. The actuating current for the magnet was supplied by two zinc and copper cells, the plates of which were arranged concentrically upon a plan devised by Dr. Robert Hare. The performances of this electro-magnet, which when excited was capable of sustaining an iron anvil weighing over 100 pounds, were occasionally exhibited for the astonishment of the simple rustics of that somewhat remote region, to whom at that day, the philosophy of electro-magnetism was a thing yet undreamed of. Thus the fame of the Crown Point "galvanic magnet" gradually spread abroad throughout all the surrounding districts.

At the period of which I write, there had grown up in an outlying portion of the township of Brandon, near the foot of the western slope of the Green mountains of Vermont, a scattered village, consisting for the most part of the homes of laborers and other employés of a recently erected blast furnace, which had been christened Forestdale. Among the mechanics whom the temporary prosperity of this new settlement had drawn from other places was Thomas Davenport, a man who had for some years lived and pursued his occupation of blacksmith in the village of Brandon, some two or three miles away. Davenport was at this time about 30 years of age; of somewhat slender physique, but of more than ordinary intelligence and acquirements, considering his educational advantages, which had been limited to those afforded during his minority, by an attendance of six weeks per year upon a common district school in a remote mountain town. He had, however, succeeded in getting possession of some fragmentary portions of a scientific book, which he was wont to pore over while laboring at the bellows of his forge, and by this means had learned at least enough to excite his desire to learn more. Shortly after his removal to Forestdale, Davenport formed the acquaintance of another artisan living there named Orange A. Smalley. Smalley was ten years younger than Davenport, bright, enterprising, and with a natural taste for scientific pursuits. Several years before, while at school at Rochester, a town a few miles distant, he had attended a lecture given in the school-house by some itinerant philosopher of that day, which had served to awaken his curiosity and interest, and so it came about that he and Davenport soon became constant and congenial companions during their brief intervals of relaxation from daily toil. Smalley at this time owned a workshop, and had accumulated a few hard-earned dollars in the diligent pursuit of his trade of blacksmithing and wagon-making. In the course of their intimacy these young men conceived the ambitious plan of increasing their scanty incomes by traveling from place to place during the winter, and delivering experimental scientific lectures. While this scheme was under consideration, and the two were endeavoring to hit upon some new feature which might add to the attractions, and consequently to the profits of their projected entertainment, Davenport chanced to hear a wonderful tale of the performances of the "galvanic magnet" at the Penfield Iron Works. His curiosity was especially aroused by the alleged suspension, by mysterious power, of a blacksmith's anvil, and he accordingly made a journey to Crown Point, 20 miles distant, to witness this extraordinary phenomenon. In this he was disappointed, owing to the inopportune absence of the proprietors. He did, however, succeed in learning that the apparatus had been procured in Albany. With the indomitable perseverance which was ever one of his most marked characteristics, Davenport forthwith set out for that city, determined to purchase a "galvanic magnet," presumably with the intention of utilizing it as one of the star attractions of the projected series of lectures. In due time he arrived in Albany, but inasmuch as he had but the most hazy idea of what the thing was that he wished to purchase, and still less of the locality where he might expect to find it, it is perhaps not to be wondered at that his researches were not crowned with success. It is worth while to quote his own naïve story of his adventures on this quest for the electro-magnet :—

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[8] Silliman's *Am. Jour. Sci.* xxvi, 205.

[9] *Annals of Electricity, Magnetism and Chemistry.* i, 75.

[10] DAVIS: *Manual of Magnetism* (Ed. of 1857) p. 212; and SILLIMAN: *Principles of Physics* (Second Ed.) p. 611, give illustrated descriptions of Page's improvement, which was made in February, 1838. SILLIMAN's *Am. Jour. Sci.* xxxv, 252.

[11] Some other early devices for producing mechanical motion by the action of electro-magnets, but which had no direct bearing upon the ultimate solution of the problem of the motor, nevertheless deserve mention as a part of the general state of the art. Descriptive memoirs of these may be consulted, as follows:

DAL NEGRO, SALVATORE.—*Nuova macchina elettro-magnetica, immaginati dall' Ab. Salv. Dal Negro.* (Annali delle Scienze del Regno Lombardo-Veneto, 10 Marzo, 1834. tom. iv, p. 67.) Padova, 1834.

BOTTO, GIUSEPPE DOMENICO.—*Notizia sopra l' applicazione dell' Elettromagnetismo alla mecannica.* Torino, 1834.

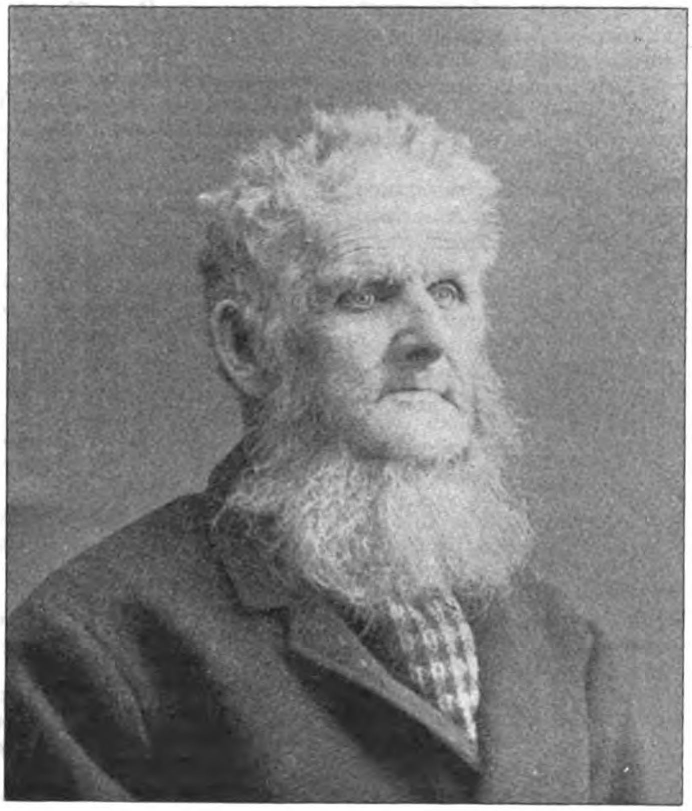
SCHULTHESS, RUDOLPH.—*Ueber Elektromagnetismus, etc.* (Lecture delivered to the Philosophical Society, at Zurich, Feb. 18, 1833), Zurich, 1835. A translation of the two papers last referred to may be found in *Taylor's Scientific Memoirs*, vol. i, part iv, p. 532 et seq.

> As I had been informed that the apparatus was a galvanic battery and possessed powerful magnetic properties, I inquired of my landlord where I should be likely to find a "magnetic battery." He replied that they "made such tubes at the tin-shops for blasting rocks," and directed me there. The tinman sent me to a jeweler's shop where he was sure "they used something of the kind in the manufacture of watches." The jeweler remarked that they had no occasion for such heavy instruments about watches, but advised me to "go to the Eagle furnace where they could cast from any pattern." At this latter place I declined calling and returned home. In December, 1833, I again went to Crown Point with the intention of purchasing some iron, and with high hopes of seeing an anvil suspended between the heavens and the earth by magnetic power. This long-looked-for mystery was finally shown me on my arrival at the Penfield Iron Works; an electro-magnet weighing about three pounds, to which was attached two sets of cups consisting of copper or zinc cylinders to be used in earthen quart mugs. The poles of the magnet were placed upon the face of a common blacksmith's anvil, and as soon as the cups were immersed in the solution of sulphuric acid and water contained in the earthen mugs, the magnet adhered sufficiently to lift the anvil until the battery-cups were removed from the solution. This had to be done by raising the cups out of the mugs, as the conductors were permanently connected together by soldering the battery conductors to those of the magnet. Here was to me one of the wonders of nature and Providence; a new kind of magnetic power! I inquired whether, if the battery cups remained in the solution, and one or both of the conducting wires should be cut in two, on connecting the conductors with the fingers or otherwise, so as to barely bring them in contact, the power would not be suddenly renewed, and as suddenly destroyed by separating them? The reply was that the power of the magnet would be destroyed, for it appeared that they had broken one of the wires which connected the cups with the magnet, and supposing the instrument spoiled, packed it up and sent it to Albany for Professor Henry to repair; whence it had but just returned. I requested the privilege of cutting one of the conductors, and connecting it together for the purpose of ascertaining this fact, but was refused. I demanded the price, and purchased the magnet for the sum of $18, instead of iron which I much needed for my shop. * * * * As soon as I became the possessor of the magnet, I immersed the cups in the solution and then severed one of the conductors, so as to break the circuit of galvanism. Of course I found the magetism wholly destroyed, but on connecting the wires together with my fingers, the magnet became again fully charged. However rapidly the connection and separation of the conductors were made, I found the charging and discharging of the magnet to correspond, and I observed that the magnet produced a hundred-fold more power than was required to make and break the connection.
>
> Like a flash of lightning the thought occurred to me, that here was an available power which was within the reach of man. If three pounds of iron and copper wire would suspend in the air 150 pounds, what would 300 pounds suspend? "In a few years," I said to some gentlemen present, "steamboats will be propelled by this power." A bystander replied, "You mean, sir, magnetic boats." "Truly so," I remarked, "and ere long this mysterious and invisible power will supersede steam; for, shall the mighty agent which suspends this ponderous mass of iron between heaven and earth, serve no other purpose than to excite our wonder and admiration? No! The human mind will not rest with so great a prospect before it, of furnishing a valuable substitute for the murderous power of steam; I venture to predict that the time is not far off, when there will be no more need of legislation and committees of inspection on steam boilers; no more aching hearts and desolate homes in consequence of the awful spectacle of human beings hurled into eternity, but the red lightning of heaven will be soon tamed and will become our servant."

Immediately upon the return of Davenport from Crown Point with the coveted apparatus in his possession, with the co-operation of Smalley experiments were commenced, with the object of producing a machine to be continuously moved by electro-magnetism. Davenport, like Fulton, Morse, Bell and many others of those to whom the world is indebted for its great inventions, appears to have been a man possessing in no unusual degree either mechanical ingenuity, or skill in handicraft. He seems rather to have been a man of broad conceptions and of prophetic foresight; one who could perceive what needed to be done, and who could select the men and the instrumentalities to do it. Above all, he was endowed with a more than common share of that indomitable perseverence and inflexible determination in pursuit of a cherished ideal, which cannot be permanently cast down nor turned aside by any obstacle, however great; which in truth can scarcely be conquered by death itself. Smalley, his associate, was a young man of acute perceptions and keen intelligence; not in any sense a trained craftsman, but rather a typical New England backwoods mechanic, "handy with tools" either in wood and in iron; with a brain fertile in expedients and contrivances to overcome unexpected difficulties. During the greater part of the year 1834, these two worked together in the building still standing at Forestdale, which at that time was occupied by Smalley as a shop. Early in the summer of that year, they succeeded for the first time in obtaining rotary motion by electro-magnetism. A permanently magnetized bar was supported at its centre of gravity like a magnetic needle. By placing the pole of an electro-magnet in proximity to the imaginary circle described by the horizontal swing of the bar, and then breaking the circuit by hand at properly timed intervals, it was found that the bar could be kept in continuous rotation. This proved to be the key to the solution of the problem of the electric motor.

After much further experimentation, Davenport and Smalley finally succeeded in completing an organized apparatus which was capable of maintaining continuous rotation by automatic means. Unfortunately, no drawing of this machine has been preserved, but the following brief description of it, written by Davenport in 1851, will serve to sufficiently explain the essential features of its construction :—

> In July, 1834, I succeeded in moving a wheel about seven inches in diameter at the rate of thirty revolutions per minute. It had four electro-magnets, two of which were upon the wheel, and two were stationary and placed near the periphery of the revolving wheel. The north poles of the revolving magnets attracted the south poles of the stationary ones with sufficient force to move the wheel upon which the magnets revolved, until the poles of both the stationary and revolving magnets became parallel with each other. At this point, the conducting wires from the battery changed their position by the motion of the shaft; the polarity of the stationary magnets was reversed, and being now north poles, repelled the poles of the revolving magnets that they before attracted, thus producing a constant revolution of the wheel.



Orange A Smalley

ORANGE A. SMALLEY.

[From a recent photograph by F. A. Grimes, of Brandon, Vt.]

The electro-magnets used in this machine were copied, with Chinese fidelity, from the Henry magnet purchased at Crown Point, which had been dissected, and the courses and direction of the convolutions of wire in its helices carefully observed. It almost immediately occurred to the experimenters that the speed and power of the machine would be greatly increased by placing a greater number of magnets upon the revolving shaft. Being unable at the time to procure the necessary copper wire for making any more electro-magnets, they tried the effect of substituting permanent magnets, at the same time increasing the number upon the shaft from 2 to 12. The result exceeded their most sanguine expectations; the wheel now revolved at such a rate that the mechanism of the commutator,—which consisted of bent wires dipping into mercury cups, moved by a cam affixed to the shaft—was utterly unable to keep pace with it.

The machine here referred to unquestionably constitutes a complete embodiment of the principles of the modern electric motor, as we have defined them in a preceding paragraph. The description of Davenport agrees in every essential particular with that recently given to the writer, from his own recollection, by Mr. Smalley, who is still living, and although almost an octogenarian, is in full enjoyment of his memory and faculties. He may be seen standing in the photographic view of his old-time shop, which forms one of our illustrations. It may be of interest to state that he did not hesitate to make a journey of several miles on one of the coldest of winter days, in order that the readers of THE ELECTRICAL ENGINEER might be favored by the presentation of the accompanying admirable and characteristic portrait.

The successful outcome of their first attempt at the construction of an electro-magnetic engine, filled the hearts of the experimenters with pardonable elation. They flattered themselves that at least they would no longer be compelled to endure the sarcastic and derisive comments of the neighbors, few of whom could be persuaded that the scheme upon which they were at work could be anything else than the "perpetual motion," which in those less enlightened days was the *ignis-fatuus* of many an ambitious rural mechanic. They met, however, with scant encouragement. The village pastor, when the mysteriously moving machine was shown to him, and the enthusiastic hopes of its constructors were poured into his ear, made the characteristic observation that "if this wonderful power was good for anything it would have been in use long before this." Nevertheless, regardless alike of ridicule, disparagement and poverty—for both were dependent upon their daily toil for the most ordinary necessities of life—Davenport and Smalley prosecuted their experiments with unwearied diligence. From some of the more intelligent of their townsmen, they received now and then a word of encouragement, and it was largely in the hope of being able to satisfy these friends that their ideas were not wholly chimerical, they determined to take the machine to Middlebury, a town 16 miles north, which boasted of an embryo college, and submit it to the inspection of those more familiar than themselves with scientific pursuits, who were presumably qualified to form a competent judgment of its merits.

ST. PAUL'S ELECTRIC RAILWAY SMOKESTACK.

The smokestack of Mr. Tom Lowry's electric railway power house is just 200 feet high, and has an inside diameter at the base of fifteen feet. It took 875,000 brick and 35,000 fire brick to build it. It weighs 19,500 tons and cost $10,000. The flue, which is eleven feet in diameter for one hundred feet from the base upward, is built of fire brick. The casing of fire brick stands like a cylinder within a cylinder, and from the outside wall. The immense furnaces which are to generate steam in boilers which are to operate engines with 7,000 h. p. capacity, would heat the smokestack up for a distance of nearly 100 feet high to such an extent that it would crack unless there was a fire brick casing inside, and this fire brick casing must have room for expansion. The exterior of the stack is octagonal in shape, faced with beautiful white pressed brick, and decorated with cornice work and figures in colored brick.

BOSTON, MASS.—The West End Railway Co. proposes to increase its capital stock by $4,500,000. Its business is growing rapidly.

A SIMPLE TEMPERATURE CORRECTION FOR COPPER WIRE.

BY

Carl Hering.

CORRECTING the resistance of copper wire for temperature involves a formula which, though not complicated, is, nevertheless, too much so to be used in many every-day calculations in which such corrections ought to be made. The writer, therefore, thinks that the very simple method described below may be of use to electrical engineers, as it reduces the temperature corrections to the simplest kind of a calculation.

Although the conductivity of the copper, and the exact diameter of the wire, are subject to variations which may in many cases be greater than the variation due to temperature, yet, in general, it is always best to make corrections as far as practicable. In many cases, as in dynamo work, the temperature correction may be of sufficient importance to necessitate its being made.

Taking as a basis, the Matthiessen standard of resistance of copper proposed by the Committee of the American Institute of Electrical Engineers, namely, 9.612 legal ohms for a wire of pure soft copper, one foot long and one mil in diameter, at 0° C. (=32° F.) and called a "mil-foot" or "circular mil-foot" standard, the writer has calculated the accompanying table. In this table the temperatures have been calculated at which this mil-foot constant has regularly increasing values, the increase being one per cent. between each two successive values. It is therefore in onc sense the reverse of the usual temperature correction tables, which may perhaps be more rational for very exact work, but which are not as rational for facilitating the computing of sufficiently accurate values for all practical purposes.

In the accompanying table the temperatures are given at which the mil-foot constant has values beginning with 10.00 and increasing by regular steps of one per cent. each, that is, steps of 0.1 ohm. To compute the resistance of a wire of any length or size for any temperature, one has merely to use the mil-foot constant given in the table which corresponds to that temperature, or to the temperature nearest to it.

TABLE OF TEMPERATURE CORRECTIONS FOR COPPER WIRE.

Resistance per mil-foot, in legal ohms.	Temperature in Fahrenheit Degrees,	Temperature in Centigrade Degrees.
10.00	50.47	10.26
10.10	55.15	12.86
10.20	59.79	15.44
10.30	64.40	18.00
10.40	68.97	20.54
10.50	73.51	23.06
10.60	78.01	25.56
10.70	82.47	28.04
10.80	86.90	30.50
10.90	91.31	32.95
11.00	95.69	35.38
11.10	100.04	37.80
11.20	104.36	40.20
11.30	108.64	42.58
11.40	112.90	44.95
11.50	117.14	47.30

The constant 9.612 being for 0° C. is of little use for direct calculation, as wires in practice are always at a higher temperature; furthermore, it necessitates multiplying by four figures, besides involving the temperature correction. The mil-foot values in the table, on the other hand, require no further temperature correction, and furthermore involve a multiplication by only two figures, one of which is always unity; for values above 96° F. there are three figures, but two of them are unity. The whole calculation is, therefore, exceedingly simple. The formula for the resistance of a copper wire at any given temperature is, therefore,

$$R = \frac{L}{d^2} K, \quad \text{or} \quad R = \frac{L}{n} K,$$

in which R is the resistance in legal olms at that temperature; L, the length in feet; d, the diameter in mils (thousandths of an inch); n $(=d^2)$, the number of circular mils; and K, the mil-foot constant at that temperature, taken from the table.

Another use of the table is as follows: If the resistance has been calculated with the constant 10.00, which is sufficiently accurate for many cases, and if it is afterwards required to know what the increased resistance is at a higher temperature, say, for instance, 78° F., the table shows that the constant is 10.60, or 6 per cent. higher; it is therefore necessary merely to add 6 per cent. of the resistance to its original value, in order to obtain the true resistance at 78° F. To do this, multiply by .06 and add the result to the original, or what amounts to the same thing, multiply the original by 1.06 (not 10.60), which gives the result directly.

Another use is, when the resistance of a wire, say, at 78° F., is known, and it is required to compute the resistance at, say, 100° F. The constants in the two cases are 10.60 and 11.10; the difference is .5, which is about 5 per cent. It is therefore necessary merely to add 5 per cent. of the original value at 78° F. to obtain that at 100°. The same value is obtained by multiplying the original by 1.05. This correction is, however, not strictly accurate, but it is a very close approximation and is sufficient for almost any case.

Another advantage of the table over the usual formula is, that it shows at a glance how much any given temperature will increase the resistance of a wire.

For intermediate values of the temperature it will be sufficiently accurate to assume a proportionate difference; that is, if the temperature is halfway, for instance, between the two values given, the mil-foot constant will be halfway between the two corresponding values. But as the temperature values differ by only about 4.5° F., such a correction will seldom be necessary in engineering practice.

The table was calculated accurately from Matthiessen's formula and the values given are therefore quite correct, assuming the formula to be correct.

The formula used is the same as is recommended by the committee above mentioned, namely:

$$R_t = R_0 \left(1 + .00387\, t + .00000597\, t^2\right).$$

This formula was solved for t, but as this gives a very complicated expression, it was reduced so as to bring it to the most practical form for calculations; it then becomes

$$t = \sqrt{(R_t - 3.5836)\ 17427.} - 324.12;$$

where t is in Centigrade degrees; R_t is the resistance in legal ohms at the given temperature; the value of R_0 which enters into the constants is 9.612 legal ohms.

THE MAYER ELECTRIC MOTOR.

THE accompanying engravings illustrate a novel type of motor which was designed and has recently been patented by Mr. Max Mayer, of this city. The aim of the designer was to produce a cheap, slow speed motor of high efficiency and the very best of mechanical workmanship. This is accomplished by the extreme simplicity of the machine and by the use of laminated iron for the whole of the magnetic circuit.

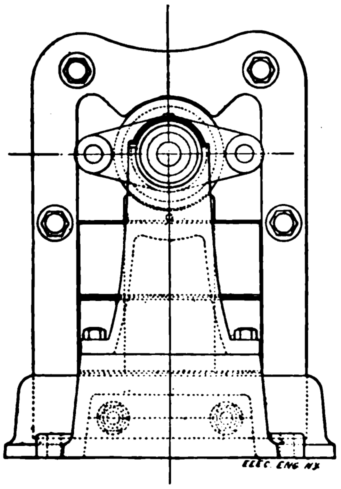


FIG. 1.—THE MAYER MOTOR.

As will be seen in Figs. 1, 2 and 3, the motor is of the single magnet two-pole iron clad type in which the whole of the magnetic circuit is stamped out of one sheet of Swedish iron, the sheets being bolted together to form the magnet frame. Both the plates and bolts are thoroughly insulated from each other to prevent the generation of Foucault currents. The field coils which are two in number are separately wound on brass spools and the height of each is slightly less than the distance between the pole pieces, thus allowing them to be slipped over the core. The whole is secured by means of two pins at alternate corners. By this method of construction there are no joints in the magnetic circuit, and consequently no leakage is due to that cause. The absence of all joints adds greatly to the mechanical stability of the machines.

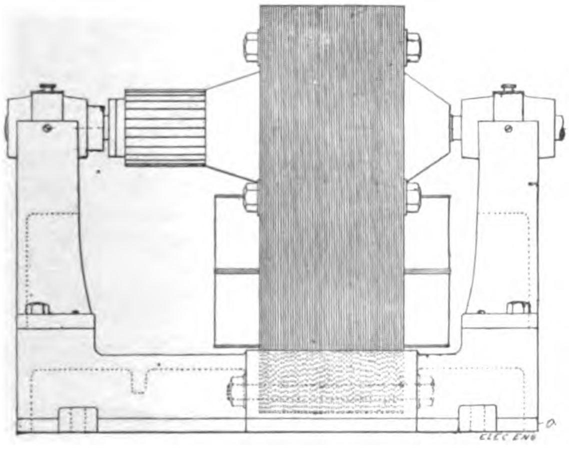


FIG. 3.—THE MAYER MOTOR.

The $\frac{1}{8}$ h. p. motor, shown in Fig. 2, has a modified Siemens armature running in bronze journals and is bolted to a wooden base by means of angle pieces, as shown. The motors from $\frac{1}{2}$ h. p. up have the plates bolted to an iron base having iron standards and self-oiling bearings, thus giving sufficient strength for the larger sizes of motors. The automatic motors are plain shunt wound and there is but a slight variation in speed between full load and no load, this being due to the great strength of field and the low resistance of the armature. There is no sparking with varying loads, the magnetism of the field greatly overpowering that of the armature, even when the machine is working at full load. The mechanical details have been carefully worked out and special care has been taken to make every part as strong and substantial as possible. The shaft is ample in size and is made of the best quality of machinery steel. The bearings are phosphor bronze and are long in proportion to their diameter. The commutator is made of Tobin bronze insulated with mica throughout and thoroughly backed. The rocker arm, brush holders, etc., are very substantial and are all adjustable.

The starting switch has a slate top, thus making the same incombustible. The machine has undergone a thorough test both as a dynamo and as a motor, and has proved to be very efficient and smooth running. There is no external magnetism whatever perceptible, which adds greatly to the efficiency of the machine, it being evident that only those lines of force are effective in the generation of currents which are cut by the armature. The well known danger of magnetizing watches is also prevented.

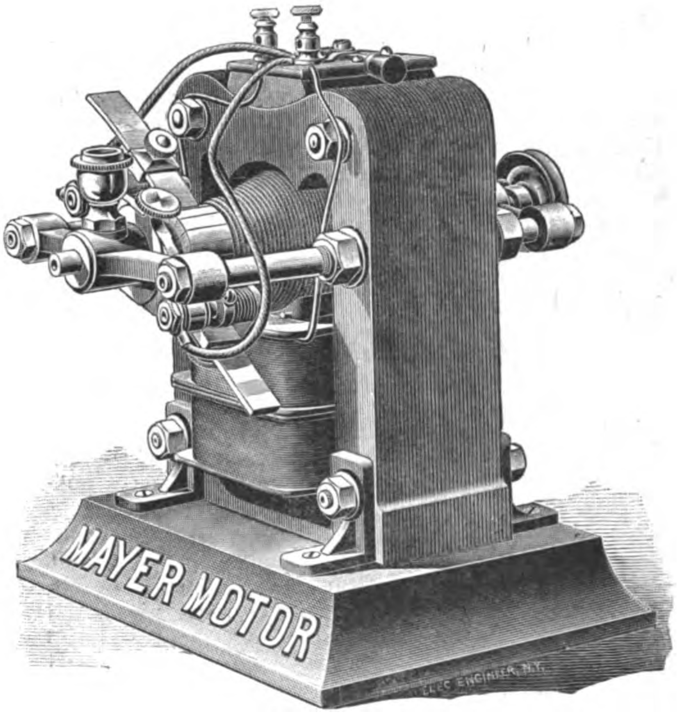


FIG. 2.—THE MAYER MOTOR.

A MUNICIPAL PLANT FOR WHEELING, W. VA.

At the last meeting of the City Council Committee on Lights and the Board of Gas Trustees, to consider the estimates on the 400-light plant for the city, Secretary Franzheim read a number of estimates from various companies. The Westinghouse Company estimated the plant to cost $101,250, and the annual running expenses at $16,000. The Fort Wayne Company put the price of the plant at $75,000, and the running expenses at $10,000. The Western Electric Company figured the plant at $61,000, and the National Electric Company, at from $65,000 to $70,000. The Thomson-Houston Company had made an error in its estimate, including only 200 lights. Mr. John Young, of Chicago, representing the Western Electric Company, stated that his $61,000 estimate provided for duplicate engines and an extra dynamo, making a complete plant.

The committee instructed Secretary Franzheim to report to Council in accordance with the facts, and to name the probable cost of the plant at from $60,000 to $80,000.

The local Wheeling Electrical Company is to have its bid in at the same time.

NEW EXPERIMENTS IN MAGNETISM.

BY

A. E. Dolbear

It has long been known that a common sewing needle will float if carefully placed upon a surface of water; also, that if the needle be magnetized it will assume a position in the magnetic meridian. Iron and steel filings will also float and they can be sprinkled upon the liquid surface nearly as well as upon a solid. If the pole of a magnet be brought near to the floating particles they will respond to the solicitations of the magnetic field in a very free and easy manner.

Let a strong U-magnet have its poles brought near to the iron filings and they will at once arrange themselves in the well-known forms, the lines being plainly seen. The induction, of course, causes adjacent particles to assume opposite polarities and consequently touch each other when free to move. If, now, the field magnet be removed the filings will retain their arrangement and if it be in a vessel large enough to permit the rotation of the whole body it will swing into the magnetic meridian if it did not happen to be in it at first, thus showing that the *arrangement* constitutes the magnet and that as a whole it possesses a magnetic field upon which the earth's field can act.

Now bring gently near the floating magnet one pole of a bar magnet. If this be presented to one of the poles of the particles it will be attracted towards it, and the whole body will rotate more or less, but this must be done slowly else the arrangement of filings will be broken up. The opposite pole will, of course, under similar conditions, exhibit repulsive action and the whole will swing about.

If, now, the magnetic pole be brought near to the middle of the arranged filings, some of the groups will be more or less disintegrated from the rest and will rotate upon a vertical axis and quite turn round. The opposite pole presented will cause them to rotate back again. Great numbers of these can be seen to turn thus whenever a pole is thus presented.

This phenomenon is evidently precisely the same in character as that illustrated at length by Ewing in his late investigations into the constitution of magnets, wherein he used small magnetic needles mounted upon pivots. The above experiments can be tried in a saucer of water, but the whole is capable of being projected with the vertical attached to a lantern and the movements of all sorts seen upon a screen with ease and very little painstaking.

THE BERGMANN CEILING BLOCK AND PENDANT LAMP SWITCH.

Among the novelties now being brought out by the Bergmann Electric and Gas Fixture Co. are the ceiling block and pendant lamp switch, illustrated in the accompanying engravings, Figs. 1 and 2. In designing the ceiling block, the object had in view was to obtain a form which should be easy of inspection and should, at the same time, readily admit of the renewal of the fuses in case of a burn-out. To accomplish this, the block is made in two pieces, of porcelain, the base piece being screwed to the ceiling, and upon this is mounted the cover block. To both these blocks are secured a pair of contacts and between these are slid in two small clips. These consist of pieces of vulcanized fibre, which carry at each side brass pieces which make contact with the corresponding pieces in the block and cover. The insulating piece is grooved diagonally and within the groove is laid the fuse wire, which connects with the two brass pieces at the end. There is thus formed a complete circuit from the top to the bottom block through the fuse wire. Should a burn-out occur, all that is necessary is to slide out the fuse clips and insert fresh ones, which can be done without disturbing the cover in the least.

Much difficulty has been experienced in manipulating pendant lamps, and as they are suspended freely the use of both hands is as a rule necessary. To avoid this, the lamp switch shown in the accompanying engraving has been designed. The switch employed is the well-known Bergmann "Universal," and the flexible wires, after passing through, are made to do the double duty of carrying the current and operating the switch; for this purpose they are led through the switch arm and hang from the end of the arm with the lamp at the end. To turn on the switch, therefore, it is only necessary to pull down the lamp, the construction being such that, as soon as released, a spring carries the lever arm back to its original position; a similar pulling down operates the switch to extinguish the lamp, so that the same motion serves to light or extinguish the lamp at will. The switch is neatly encased in a brass cover and mounted on a porcelain base.

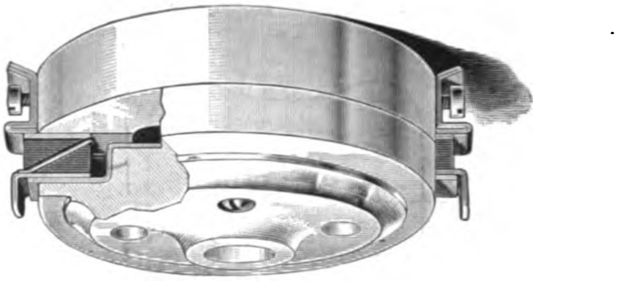


Fig. 1.—Bergmann Ceiling Block.

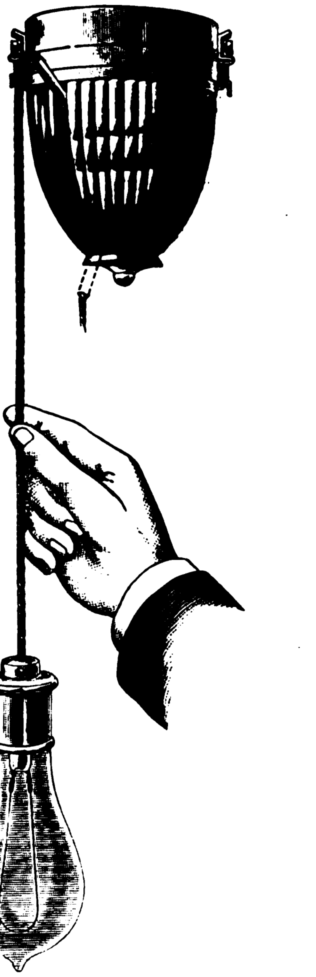


Fig. 2.—Bergmann Pendant Lamp Switch.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—VIII.

(*Copyright, The Electrical Engineer.*)

BY

Herbert Laws Webb

ACCESSORIES.

ANOTHER very useful accessory on a testing table is illustrated in Fig. 28. It consists simply of a brass plate carrying a number of binding posts and serves for connecting the various instruments to earth. Connection with earth is required in several tests and the brass earth plate makes a very neat job of the connections, which, if made by simply twisting the wires together, would present anything but a sightly appearance, to say nothing of the risk of poor contacts. The end terminal of the plate is connected to a good earth by means of a substantial lead, and when it is necessary to put any of the keys or instruments to earth, the only operation requisite is to run a wire to one of the spare binding-posts of the plate.

An improvement I would suggest on this plate is that it be made in two parts, one part carrying the terminal to which the earth wire is connected and the other the remaining terminals for the instrument connections. The two sections of the plate could be connected or disconnected by the insertion or removal of a plug. It is sometimes necessary, as when testing two wires looped at the distant end for conductor resistance, to remove the earth connection, and the simplest method of doing this is by taking out a plug. If the wire is taken off the binding post it is apt to be overlooked afterwards and cause trouble, but the absence of a plug from its proper place is more noticeable.

PRACTICAL TESTING.

The reader has now been introduced to the various instruments used for cable testing, and next in order are a few definite directions touching on the manner of using them so as to obtain useful results. What may be called the theory of the different tests, and the action that goes on during their application, have already been explained and illustrated diagrammatically in Figs. 1, 2, 3, 4, 5, 6 and 7. The diagrams that follow show the actual connections of the instruments for making the different tests, and a comparison of the two sets of diagrams should give a very clear idea of the subject of practical testing.

In the earlier diagrams, some of the keys and connections were omitted in order that the path of the current and its action might be made as clear and intelligible as possible, and the appearance of each pair will therefore differ materially; but nevertheless no difficulty should be found in understanding the relations between them, and it has been my endeavor throughout to make explanations and descriptions, even at the risk of prolixity, so detailed and full that even those who have never seen a set of testing instruments (if such there be), might be able to derive a clear idea of how the work is done and what goes on during each test.

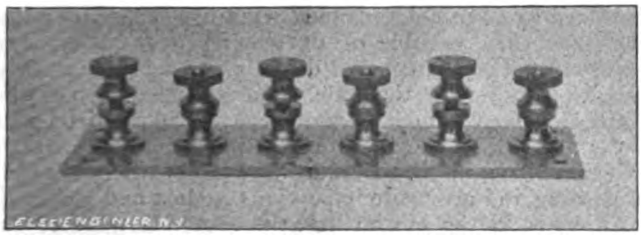


FIG. 28.—BINDING POSTS FOR EARTH CONNECTION.

THE GALVANOMETER CONSTANT.

Before testing a wire for insulation it is necessary to take the constant of the galvanometer in order to obtain a value with which to compare the deflection given by the wire or cable. The connections for taking the galvanometer constant are shown in Fig. 29.

A high resistance of 100,000 ohms, or one megohm, is placed in circuit with the battery and galvanometer, which is shunted with the $\frac{1}{999}$ th or $\frac{1}{99}$ th shunt, and the deflection obtained by a steady application of the current is the constant of the galvanometer. The battery power should be the same as that used for testing the cable, or if the galvanometer is so sensitive that, with the full battery, too large a deflection is obtained, half the number of cells may be used and the resulting deflection doubled. A better plan, however, is either to use a very high resistance or to shunt the galvanometer with a low resistance so that the full number of cells will give a readable deflection.

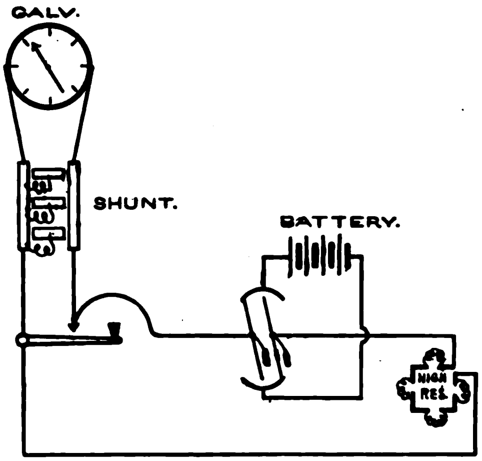


FIG. 29.—CONNECTIONS FOR TAKING GALVANOMETER CONSTANT.

Tracing the connections in the diagram we see that one side of the battery key is connected to one terminal of the short circuit key, the other side of the battery key going to earth. The opposite side of the short circuit key is connected to the high resistance, which is also connected to earth from the other side. The wires from the shunt are taken one to each terminal of the short circuit key. When the current is turned on the circuit is established through the lever of the short circuit key and the high resistance. On depressing the lever of the short circuit key the galvanometer is thrown in circuit and the deflection is obtained. By tapping the short circuit key a few times the needle will be moved gradually along the scale instead of swinging far beyond the mark and oscillating for some time; with a little practice the short circuit key may be so manipulated that very little time is lost in bringing the needle to rest, either at the figure of the deflection or back to zero before turning off the current. The deflection should be the same with both poles of the battery; if there is any appreciable difference the suspension is probably slightly twisted or the battery is inconstant, probably owing to bad insulation.

Assuming that the constant is taken with a battery of 100 cells, a high resistance of 100,000 ohms and a shunt in the galvanometer circuit of $\frac{1}{999}$ th, and a deflection on the scale of 300 divisions is obtained, this result should be written down as follows:

Galvanometer Constant: 100 cells, 100,000 ohms, S $\frac{1}{999}$, def. 300=30,000.

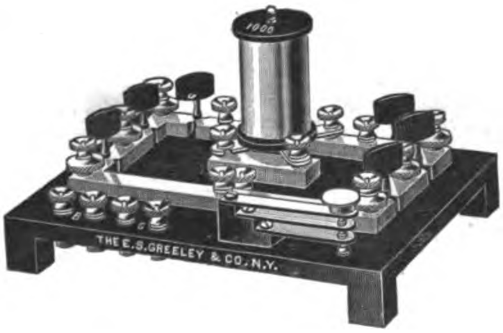
The last figure, thirty-thousand, is the deflection that 100 cells would give through one megohm with no shunt in the galvanometer; or, in other words, 100 cells would give a deflection of one division on the scale through a resistance of 30,000 megohms.

To obtain the grand constant the deflection observed is multiplied by the power of the shunt used and by the resistance in circuit. In the case imagined the multiplying power of the shunt is 1,000 and the resistance $\frac{1}{10}$th of a megohm; consequently the grand constant is $300 \times 1000 \times \frac{1}{10} = 30,000$.

In noting down the galvanometer constant on a test sheet it is best to give all the details of number of cells, shunt and resistance employed, and the deflection obtained, in the form given above. If necessity should arise at any subsequent date for examining the report no doubt can then arise as to whether the same battery was employed throughout the test, or whether the constant was correctly calculated; and if all the data is properly noted down the test can be worked out again should there be any doubt as to the results; whereas if these details are omitted there is no check on the correctness of the working or the reliability of the test.

THE FREY ELECTRICAL BALANCE OR REVERSIBLE BRIDGE.

This instrument, designed by Mr. Charles P. Frey, chief electrician of the E. S. Greeley Electrical Laboratory, is specially adapted for rapidly measuring both high and low resistances, with unusual precision. It is intended to be used in connection with an adjustable resistance box or a B. A. pattern standard coil, and takes the place of the bridge coils which form part of the rheostat of the conventional pattern. The peculiar feature of the instrument is that its bridge coils can be tested by reversing or interchanging them, an operation which can be speedily performed. Should any inequality exist it can be quickly corrected. Both bridge coils are shunt wound upon one spool and can be removed to give place to others of higher or lower resistance. A wire bridge with subdivided half-meter scale can also be attached. This apparatus is being placed on the market by The E. S. Greeley & Company, New York, proprietors of the Greeley Laboratory.



The Frey Electrical Balance.

MR. FERRANTI ON HIGH PRESSURE INSULATION.

In a communication to the London *Electrical Review*, Mr. S. Z. de Ferranti writes as follows:

To begin with, I may say that the amount of "wild talk" about 10,000 volts is quite unwarranted, especially as the people who speak about it have, practically, no knowledge on the subject. 10,000 volts, although it can be worked, and machinery and cables made to stand it, is not a thing which at the present moment is as easily dealt with as some people may imagine. Moreover, I may say that a cable which has to be used for a daily supply of 10,000 volts must be able to stand a very prolonged test of 25,000 volts at least, with a considerable h. p. at the back of it.

Now, as regards the statement as to the abandonment of the Fowler-Waring cable by the London Electric Supply Corporation, Limited, I may say that this is quite incorrect. The only trouble that there has been with the Fowler-Waring cables has been in what they have been called, not in the cables themselves. They were, and are, first-class cables for the purpose for which we are using them, viz., the supply of current at 2,500 volts. If the cables were required for a higher pressure they would have to be more heavily insulated, and this no doubt can easily be understood.

I may also add that our permanent distributing work is being done with insulators other than India-rubber, and that I do not propose to use India-rubber where I wish to have a lasting permanency.

THE NEW BAXTER ELECTRIC RAILWAY MOTOR.

Among the names of those who early entered the field as designers and builders of electric motors, none is perhaps better known than that of Wm. Baxter, Jr., of Baltimore, whose arc motors have long held an enviable position among the successful machines of to-day. More recently, however, Mr. Baxter has devoted much of his attention to the designing of constant potential motors and more particularly to electric railway motors.

Recognizing the acknowledged disadvantages now encountered with high speed motors employed in that service, Mr. Baxter has accordingly started out at once with the idea of reducing the speed of the armature, so as to avoid all intermediate gear. A reduction of speed of armature, other things being equal, necessitates a corresponding increase in torque, and to effect this the multipolar motor has been adopted by Mr. Baxter; but the problem of arranging such a machine under the car, with sufficient clearance between the ground and motor, was by no means a simple one; but it has been successfully solved with the additional important advantage of a reduction in weight of the motor mechanism.

In order to demonstrate the thoroughly practical character of the new motor, a large number of invited guests, including the Mayor and many of the prominent citizens of Baltimore, as well as others from New York, Boston and Washington, assembled at the works of the Baxter Electric Motor Co., at Baltimore, on Dec. 27, where the car was put through a most severe series of tests. The track, situated on the grounds of the company, was about one-eighth of a mile in length and included four sharp curves and a grade of three per cent. With every available space on the car occupied by the visitors, no difficulty whatever was experienced in starting and stopping on curves and grades, the smoothness of starting under these conditions being especially noteworthy.

The manner in which these results have been accomplished will be understood from the description of the motor and gear arrangements which are illustrated in the accompanying engravings.

Mr. Baxter has adopted a machine having eight poles energized by four field magnet windings. Two of these machines, each capable of developing over 20 h.p., are employed. They are geared directly to each axle at both ends, thus relieving the axle from all unequal twisting strain. The steel pinions on the armature and cast-iron gears on the axles are encased in dust and waterproof cast-iron casings and run in oil. Besides this, the bearings are self-lubricating and are made impervious to dust and grit.

As shown in the engravings, the motor is flexibly suspended in every direction and its free end is attached to a suspension frame which rests on the springs that support the central portion of the car body. This suspension frame moves with the car body and thus has all its elasticity of motion. By this method of suspension the danger of breaking the circuit connections to the motor is avoided, as the points to which they are attached move together with the car body and thus always preserve their relative positions.

Another important feature of the mechanical construction consists in the position of the brushes; the motor being an eight-pole machine, the brushes are placed at an angle of 45 degrees and directly on the top of the machine, Thus, by removing the trap door in the floor of the car both brushes can be readily got at. The brush holders, which are very substantially constructed, hold the carbon brushes firmly and free from vibration, and permit of the ready removal of the brushes.

The armature employed has a diameter of 18 inches and the field magnets are, by an ingenious design, so shaped that, notwithstanding the employment of eight poles, the extreme height of the motor does not exceed 19 inches. As a result, the car body does not require to be raised above the ordinary height and the machinery is still over 5 inches above the level of the track.

The speed of the armature is equivalent to 42 turns per minute per car mile, so that at a speed of 7 miles per hour the armature revolves at only 294 revolutions. To obtain this speed the pinions on the armature shaft are 4½ inches in diameter and mesh with 18 inch gears on the axle, the car wheels being 30 inches in diameter.

The torque at the periphery of the armature is 175 lbs. with 15 amperes, 350 lbs. with 22½ amperes, and 530 lbs. with 30 amperes, the torque at the pitch line of the gears being evidently four times the torque on the armature.

The economy in weight effected by the construction adopted will be appreciated by the following table of weights:

Weight of 4 field magnets	340 lbs.
" " armature	205 "
" " commutator and shaft	150 "
	695 lbs.

If we add to this 200 lbs. for the weight of the frame we have approximately 900 lbs. as the entire weight of the motor proper. The weight complete of the power mechanism for each motor, including gears, shaft, casings, etc., does not exceed 1,500 lbs., thus showing excellent economy in weight.

With 900 lbs. weight of motor proper, therefore, and having with 30 amperes a torque of 530 lbs., at the periphery of the armature 18 inches in diameter and running at 300 revolutions per minute, we obtain the following -power.

$$\frac{4\frac{2}{3} \times 300 \times 530}{33,000} = 22.4 \text{ h. p.}$$

This gives, therefore a weight of 900 + 22.4, or 40.4 lbs. per horse-power of motor. If, instead of 300 revolutions, the motor were run at 1,000 it would then actually develop no less than 77 h. p., equivalent to a weight of 11.7 lbs. per horse-power.

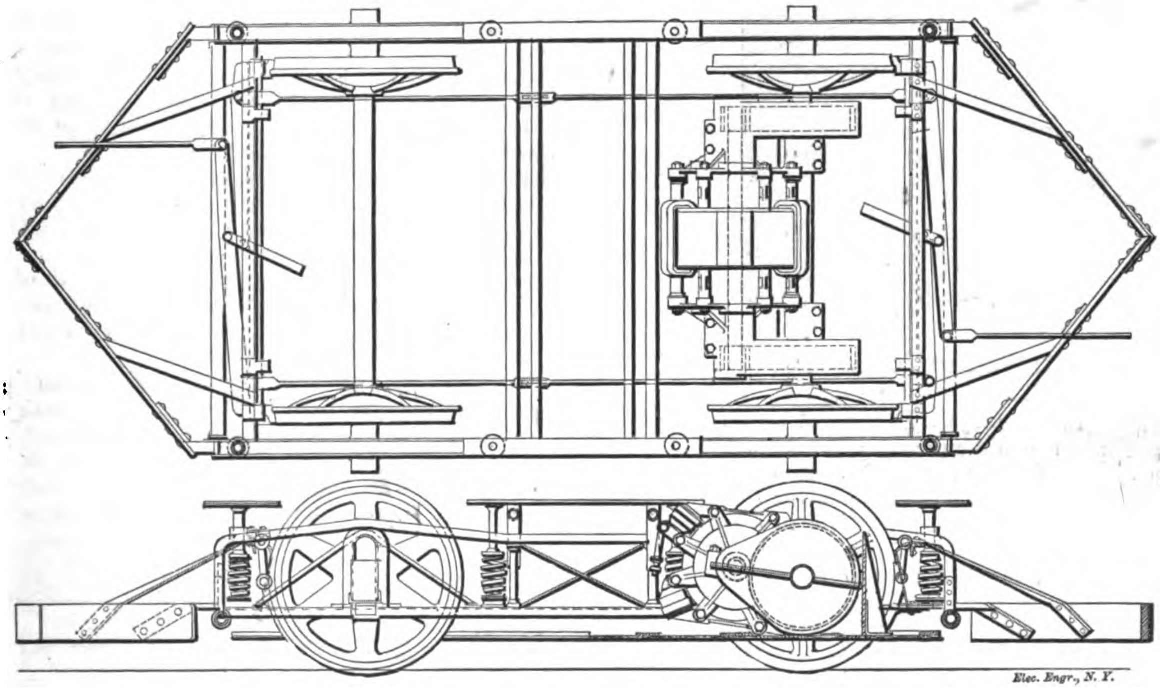
We come now to the electrical details which have been very carefully worked out. The exposed position of a street car motor makes the question of insulation one of paramount importance and to effect this in the most complete manner, Mr. Baxter has so designed the machine that the armature core as well as the commutator hub are entirely insulated from the shaft. The armature coils, in addition, are insulated from the core with mica.

The motor is series wound and each of the four field magnets is subjected to an induction of 5,000 ampere turns. The iron cores weigh each 67 lbs. and are built up of laminated soft iron; they are wound with 203 turns of No. 9 wire, weighing 18 lbs. The total resistance of the fields which are all in series is therefore 1.4 ohm.

The armature is 18 inches in diameter and 9 inches face. It is wound in 136 sections connected to a like number of commutator bars. Each section consists of 12 turns of No. 11 wire, and the total resistance of the armature is 1.03 ohm. As stated above, the brushes are placed at an angle of 45 degrees.

The car is governed entirely by the manipulation of a single crank lever under the control of the driver, the car going ahead, or reversing, in the same direction as the movement of the crank lever, and the speed being exactly in proportion to the distance through which the crank is turned. The regulation is effected by means of a rheostat which is completely fireproof and of the most simple construction. The resistances are constructed so as to possess considerable self-induction as a protection for the armature against lightning. To this end the lightning srrester is connected to the trolley wire, and the rheostat placed between the armature and the lightning arrester. The high counter E. M. F. of self-induction of the rheostat therefore forces the lightning charge to take the path to ground through the arrester, in preference to the armature, thus leaving the latter unharmed.

These constitute the salient features of the Baxter railway motor, which has been constructed under the superin-



FIGS. 1 AND 2.—BAXTER ELECTRIC RAILWAY SLOW SPEED MOTOR.

tendence of Mr. David E. Evans, superintendent of the Baxter Electric Motor Company, and which seems to possess all the qualities which will insure success in actual practice, as was abundantly demonstrated in the recent test.

THE BERGMANN AUTOMATIC SWITCH.

In wiring buildings it is rarely the case that switches, which must be conveniently located, can be inserted directly in the line leading from the main or branch to the lamps. In the majority of cases, therefore, considerable lengths of conductors are practically wasted in making a detour from branch to switch and from the switch to the lamps; and where the latter are at a considerable distance from the switch the loss in conductors may reach a considerable item.

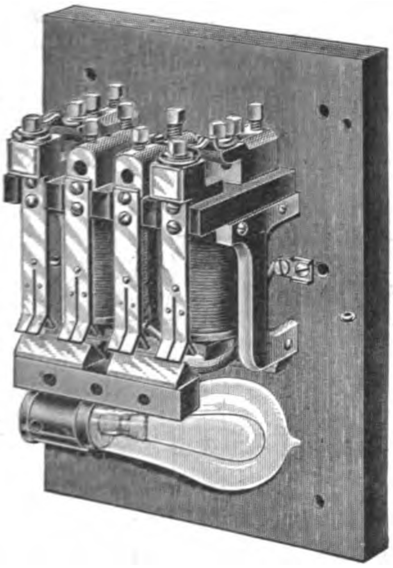


Fig. 1.—Bergmann Automatic Switch.

An arrangement, therefore, in which the switch can be placed close to the lamps and directly in the line of the conductors and operated by small wires from a distance will be acknowledged to be a valuable addition in the wiring equipment of a building and this has been successfully accomplished in the new automatic switch just brought out by the Bergmann Electric & Gas Fixture Co., of this city, which is illustrated in the accompanying engraving, Fig. 1.

As will be seen, the switch consists of a pair of electro-magnets, an incandescent lamp for a resistance, and the switch proper.

Two push buttons are necessary to operate it, one to close the circuit for lighting, and the other to extinguish the lamps by opening the circuit.

The operation of the switch will be readily understood by referring to the accompanying diagram, Fig. 2. As will be seen, the mains, M^1, M^2, are connected to one set of contacts and the contacts between them are joined to the branches B^1 and B^2 in which the incandescent lamps are included. The push buttons, which are mounted in a small box conveniently placed, are connected by fine wires, P^1, being connected to the main M^1, and P^2 with the branch B^2, the one being negative, the other positive. The third wire to the push button is joined between the lamp L and the switch magnet SM, as shown.

It will now be readily seen that when the button P^1 is pressed the circuit is closed through the electro-magnet SM, which attracts the armature A and closes the contacts through the clips *c*. As soon as the button is released, the circuit is established between the switch magnet and the lamp L in series, so that the current passing through lamp and magnet is immediately cut down to one-tenth of an ampere and remains at that while the switch is closed.

When it is desired to cut out the lights, the push button P^2 is pressed, which short circuits the switch magnet SM and allows the armature A to be retracted by the spring, thus opening the switch.

As the current used to operate the switch is about one-tenth of one ampere, a very thin wire will carry the current to the push buttons. In a house installation every circuit may now be controlled with a few neat push buttons in the hall-way where unsightly hand-switches would not be tolerated.

It is evident that any number of push buttons may be attached to the same switch so that any circuit may be controlled from any point desired. Thus, in ordinary house lighting every floor can be controlled from each floor; for instance, if three floors were to be controlled it would only be necessary to run three thin wires from top to bottom connecting respectively with switch No. 1, 2, and 3. With three push buttons on each floor, every switch can be operated from any floor.

The switch can be utilized for a great variety of purposes, for many of which it would be impossible, or too costly, to apply the ordinary hand-switch, such as running electric elevators; here the operator merely handles a small lever or controls his car with two push buttons.

It also enables motors for any purpose to be controlled from any desired point.

In buildings where the current is generated locally, each floor or circuit can be operated from the dynamo room with push buttons and thin wires connected to the switch. The main or lighting circuit would consist in this case of one pair of mains running the entire length of the circuit with a switch at each branch, thus saving the cost of running separate wires from the dynamo room to each circuit, as is now the general practice.

For store or office lighting the switch can be operated by a clock so as to connect the lights at a certain hour and also to disconnect them at any desired time. For electric heating, in conjunction with a thermometer or thermostat the switch constitutes an absolute temperate regulator. By connecting the switch to a burglar alarm system the lights all through a building can be thrown on the moment a door or window is opened. Many other applications of the switch which is made in all sizes will suggest themselves to our readers, and its appearance marks a distinct advance in electric wiring appliances.

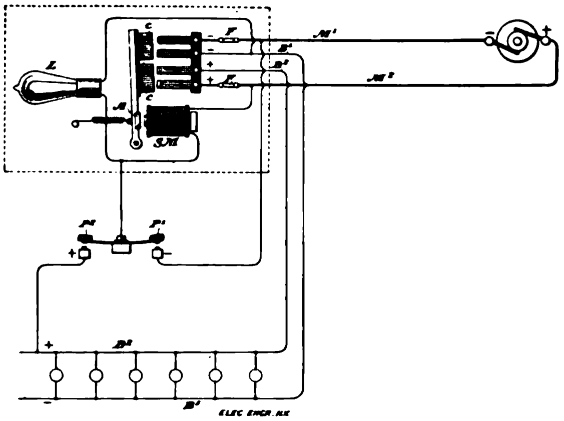


Fig. 2.—The Bergmann Automatic Switch.

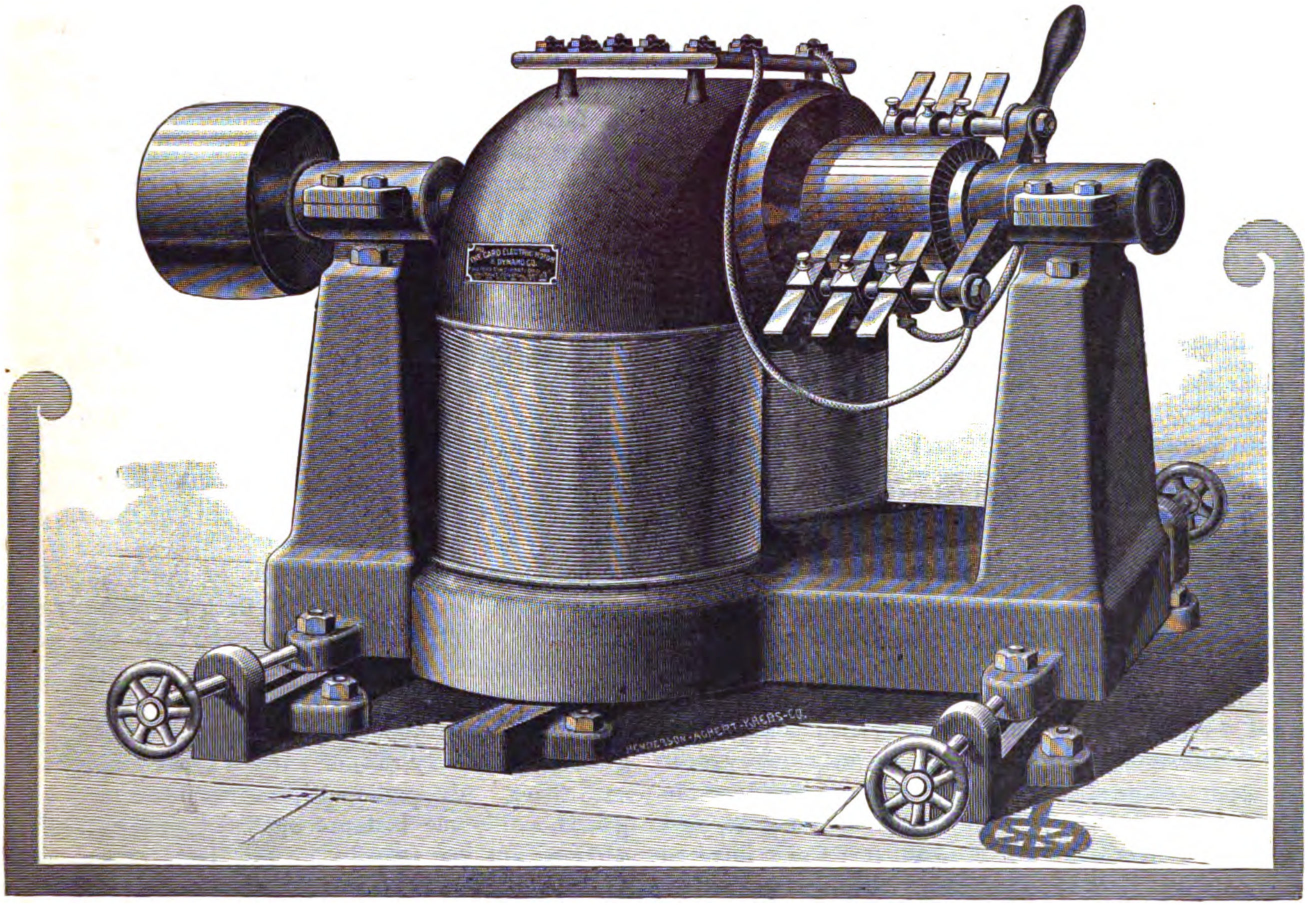
ELECTRICITY IN SINGAPORE.

A reader of The Electrical Engineer at Singapore, Strait's Settlements, India, writes us of the paper: "It is an old friend and finds a generous welcome. Electric lighting has found its way into Singapore and illuminates the Government house. I see no reason why American plants should not find a ready market on the Asiatic coast."

THE NEW CARD ELECTRIC MOTOR AND DYNAMO.

Among the machines recently brought out and designed both as a motor and dynamo is that of the Card Electric Motor and Dynamo Co., of Cincinnati, O., and which is illustrated in the accompanying engraving.

This type of machine has been adopted by the company for all their motors above 8 h. p., and incandescent dynamos from 100 to 400 lights. The motor, as shown, is very simple and compact, occupying very little space in proportion to the power produced. The fields and pole-pieces are of one solid wrought iron forging. These fields are set into a cast-iron base, which, with the end bearings, form one solid casting. The bearings are self-oiling, and have an interchangeable phosphor bronze sleeve, thus making the motor a very durable, economical and efficient machine.


HENDERSON-ACHERT-KREBS-CO.

The New "Card" Motor and Dynamo.

SELENIUM CELLS USED FOR COMMERCIAL PURPOSES.

Mr. Shelford Bidwell, at the end of an interesting paper read at the Physical Society, showed a selenium cell controlling a relay which served several purposes. For instance, there was an arrangement of a selenium cell which turned on a little lamp on the approach of darkness, and turned it out when daylight reappeared. Another arrangement of the cell served the purpose of giving notice if a burglar showed a light anywhere in its neighborhood. To avoid this result, a scientific burglar will, perhaps, be provided in future with a yellow glass in his "dark lantern." The cell could also be used to give notice if a railway signal lamp or ship's side lights should be extinguished. The arrangement has also useful applications as a fire alarm.

AN ILLUSTRATION OF EWING'S THEORY OF MAGNETISM.

BY PROF. S. P. THOMPSON, D.SC.

A number of small "charm" compasses were placed together on a glass plate of an ordinary vertical attachment to a lantern. A large magnet at a distance served to neutralize the earth's field, and a coil enabled a magnetizing force to be applied in the plane of the needles. By this apparatus all the various phenomena exhibited by Ewing's model were beautifully shown on a screen. In the course of his experiments Dr. Thompson had found that when small magnets, placed at moderate distances apart, were used it was much more necessary to neutralize the earth's field, in order that they might set themselves according to their mutual attractions, than when larger magnets were employed. A weak field directed the small openly spaced magnets, whereas with larger ones their mutual actions were much more powerful. This fact may, he thought, throw some light on the molecular groupings in magnetite (loadstone). This substance exists in two forms, one crystalline and the other of a heterogeneous structure. The former variety exhibits no magnetic retentiveness, whilst the latter is decidedly magnetic. As far as he was aware, no sufficient explanation had been given of the non-retentiveness of the crystalline variety. A difference in the molecular distances or grouping might account for the peculiarity. Mr. Boys said it was rather curious that Prof. Rucker had just devised a somewhat similar illustration of Ewing's theory, and he exhibited it at the meeting. It consists of little magnets made of long U-shaped pieces of watch-spring, pivoted by glass caps on needle-points; the needle-points are fixed in little discs of lead stuck on a sheet of glass, which forms the base of a glass box. An open helix surrounding the box serves to apply magnetic force.

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1. Abstract of a paper read before the London Physical Society.

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Vol. XI. NEW YORK, JANUARY 7, 1891. No. 140

The subjugation of electricity to the mechanical necessities of man will mark the last era in human civilization.—John C. Calhoun.

FIFTY YEARS OF INDUSTRIAL ELECTRICITY.

THE fact that the year which has just closed was the jubilee or semi-centenary year of the electric motor, considered in its industrial aspect, appears to have entirely escaped the attention of our chroniclers. The history of the early attempts in this country to evolve motive power from electro-magnetism has hitherto been involved in no little obscurity. Beyond the tradition—which we find occasionally referred to—that a newspaper was printed in the city of New York in 1840, upon a press driven by electro-magnetism, and some meagre and unsatisfactory accounts of the experiments made by Page, under the patronage of the government some ten years later, the American annals of electric power up to within a few years are little better than a blank.

It seems peculiarly appropriate, at the beginning of the second half-century of the industrial career of electro-magnetism as a motive power, that the history of its infancy and childhood should be revised and rewritten by a competent and unprejudiced pen. At an earlier date indeed it would scarcely have been possible to justly weigh and apportion the merit of the work of the pioneers and to rightly comprehend its actual relation to the perfected state of the art as it exists to-day. We feel therefore a peculiar satisfaction in announcing that this work has been undertaken by Mr. Pope, in the series of papers of which the first instalment is given in the present issue of The Electrical Engineer, and when we state that he has had access to numerous family letters, papers and other contemporaneous manuscripts never before published ; that he has personally visited, sketch-book and camera in hand, the scenes of the labors of the early experimenters ; that he has conversed with surviving eye-witnesses, and ransacked the files of the publications and pamphlets of half a century ago, and moreover that he brings to the work the experience of a trained expert in patent law, and the skill of a practical writer, we think we may promise our readers a series of papers the immediate interest of which will only be equaled by their permanent historical value. The researches of Mr. Pope appear to establish beyond peradventure, the fact that the typical motor of to-day is in all its essentials a machine of independent American origin, and we feel well assured that the hitherto undiscovered evidence which he presents in support of this claim, cannot but prove of unexampled interest to electricians on both sides of the Atlantic. Mr. Pope's work supplies, in the most satisfactory manner, what has hitherto been regarded as the one missing chapter in the annals of electro-magnetism, and we congratulate our readers and ourselves upon the good fortune and success which has attended him in his interesting researches.

SLOW SPEED STREET CAR MOTORS.

The tendency to the reduction in speed of motors used in street railway service is becoming more and more marked as time passes, and as the benefits which the application of such machines confer upon the operation of the street car become recognized. From the early methods of the belt and sprocket wheel and chain the system changed gradually to that of spur gearing, which is now generally employed, but which on account of the high speed had required two pairs of gears to effect the proper reduction at the car wheel. Recently, also, no little ingenuity has been expended in devising methods of gearing by which the motor might be kept in continuous operation and its motion gradually applied to the car axle in starting, thus avoiding the heavy rush of current usually experienced at such times. Although multipolar machines have been suggested, and in one instance applied to railway work, the arrangement we describe in this issue and due to Mr. William Baxter, Jr., is worthy of notice as it is the first instance of the application of a machine having as many as eight poles. The design of such a machine to fit under a car without necessitating the raising of the platform above its usual height and still leaving a clearance sufficient to avoid all contact with possible obstruction along the track, will be conceded to be a problem of no small difficulty, but the results which have been accomplished, as exhibited in the recent trials which we had the pleasure of attending, leave no doubt in our minds that the arrangement adopted is a perfectly practical and successful one. The gearing of the motor shaft directly to the axle of the car, doing away as it does with the use of an intermediate pair of gears, necessarily avoids considerable friction and loss of power. It is obvious that by the employment of an armature of large diameter subjected to the induction of a multipolar field, the large torque exerted effects a rapid starting of the car and the counter E. M. F. quickly generated by but a small motion of the armature tends to cut down almost entirely the sudden rush of current which is observed when two-pole machines are employed in such service. The mechanical arrangements embodied by Mr. Baxter in his new design are also worthy of attention as removing some of the difficulties which have been experienced in the past in railway work.

ELECTRIC LIGHTING IN LONDON.

After a long period of apathy and inaction, not due to any lack of ambition on their part, but to the restrictions placed upon them, the local electric lighting interests of London are genuinely aroused, and, in spite of the temporary financial depression, one hears of an immense amount of new work being done there. The actual status of electric lighting in the British metropolis is well brought out in the figures of Mr. Bailey, given before the English Society of Arts, and effectively summarized by our London correspondent. It will be seen that Mr. Bailey, who is in a position to know, figures out a total of no fewer than 264,000 incandescent lamps of 32 watts each, in London. The present rate of increase is given as 4,000 per week, so that the total may be doubled within another year. It was also stated in the subsequent discussion that the total for London was twice as large as for New York. This is a mistake. Although no recent statistics have been taken here, the figures for both cities are pretty nearly the same, favoring New York, and there is, moreover, an additional 10,000 h. p. of arc lighting in New York. Besides, the comparison even then is not a correct one, as London is a city at least three times as large as New York. However, be that as it may, our London friends cannot be congratulated too warmly on the magnificent showing they make. It has been reached across greater obstacles than we have had to contend with in America, and though they do not yet run stations as well as we do they certainly put more money and pains into their construction work. The results attested to by Mr. Bailey are most gratifying to all who are working for the ultimate supremacy of the electric light in the field of artificial illumination.

Storage Battery Analysis.

The work of Gladstone and Tribe on the chemical actions taking place in the operation of the storage battery, has, with but few additions, such as those of Frankland, been the chief source of our information and has helped to a considerable extent in eliminating some of the early difficulties. At the meeting of the London Institution of Electrical Engineers, at Edinburgh, early in the past year, Prof. Ayrton and his associates embodied in an admirable paper the results of a series of tests which are now supplemented by another paper of which we give an abstract. The two papers taken together have given us the results of what is unquestionably the most extended series of tests thus far undertaken in storage battery work, and the conclusions derived from them throw much light on disputed points. The variations in the composition of the active material on the positive plate, as charge and discharge proceed, both as to its general character and the differences existing in various parts of the same plate, prove that much can still be done to obtain higher efficiency and uniformity in storage battery electrodes.

A Floating Magnet.

Floating magnets, consisting of steel pieces mounted upon cork, constitute one of the oldest forms of classroom experimental apparatus, but a decided novelty, in more senses than one, is the floating magnet devised by Prof. Dolbear, which he describes in another column. The experiment serves not only to demonstrate the presence and directive action of the earth's magnetism, but gives also an ocular demonstration of the magnetic lines of force. In addition to this, it demonstrates the property of magnetic retentivity and the molecular structure of a magnet, as brought out in Ewing's recent theory. It would, indeed, seem difficult to devise a single arrangement embodying more of the principles and phenomena of magnetic action than this simple and beautiful experiment. Its ready adaptability to demonstration before large audiences, also, is not the least among its merits.

The Deadly Christmas Tree.

During the past week the papers have teemed with accounts of accidents and deaths from Christmas tree fires, and as this cannot be endured in a civilized community, a movement has been started, we are glad to say, to suppress the deadly thing. It is proposed to establish a Board of Christmas Tree Control, one of whose duties it will be to see that none but incandescent lamps are used on the trees hereafter, and who will prepare rules and regulations for their enjoyment. It has been objected in one or two quarters that during 11½ months of the year, the Board will have nothing to do, but while this criticism is laughed at by the city authorities, as puerile, it is seriously suggested that the inspectors of the Board can employ their leisure and greatly lessen the loss of life and injury to limb of the citizens by being also given jurisdiction over orange and banana peels if thrown on the sidewalks. One of the papers that has been very outspoken in its opposition to the electrical execution law, has hastened to improve the occasion and the prevailing sentiment by proposing that condemned murderers shall be given candle-lighted Christmas trees to play with. The suggestion is not without its merit, as the criminals would thus pass to their doom while in the pleasant state of exhilaration that arises from participation in innocent pleasures.

Automatic Electric Light Switches.

It was long ago told of Mr. Edison that in starting out to produce successful commercial incandescent lighting he set himself the problem of creating a system which should in every way be able to replace gas. But one of the devices which has been employed in gas lighting seems thus far to have been neglected in electric lighting. We refer to the very convenient automatic burners which are operated by push buttons placed in any convenient position. It is obvious that an automatic switch similarly operated from a distance to effect the turning on and extinction of lamps must find a large number of applications, and the device for this purpose which we describe in another column will therefore be read with considerable interest. It is true that the switch generally employed to control any light may be placed in any convenient position, but the loss in wire entailed in the detour usually necessary, makes a device by which this inconvenience is obviated, one of considerable value and convenience.

ROWLAND AND DUNCAN'S SYSTEM OF STORAGE BATTERY DISTRIBUTION.

Of the various methods for effecting the distribution of current with economy in conductors that involving the employment of storage batteries, though presenting not a few advantages, has not received the attention which the merits of the system would seem to deserve. It is evident that storage batteries can be located at a distance from a central station and charged in series with a high tension current transmitted over a small conductor, and discharged in parallel at low tension to the surrounding district.

A method of accomplishing this transformation by means of a commutator has recently been designed by Prof. Henry A. Rowland and Dr. Louis Duncan, of Johns Hopkins University, Baltimore. In this system the commutator and the shifting connections are so arranged that neither the charging nor the discharging circuit is ever broken at any time, but both are always continuous.

The manner in which this is carried out is illustrated in the accompanying engravings, Fig. 1 showing a diagram of the circuits with the commutator-cylinder developed as a flat surface, and Fig. 2 a view in elevation of the commutator with a diagram of the circuits.

As will be seen, the high tension dynamo D at the central station is connected by wires *a a* with the commutator G at the distributing station. The commutator of the tension-reducer consists of a cylinder of insulating material and carrying metal contact strips on its surface, upon which bear the contact brushes, numbered from 1 to 24.

A B C each represent one of the sets of secondary batteries. The cylinder is rotated rapidly by an electric motor H which receives current from either the high tension or low tension circuit.

The contact-strips on the cylinder are divided into sets, there being two sets of strips for each set of secondary batteries—one set for charging and the other for discharging. The strips marked *c*, *c'* and c^2 are for charging and are connected in series. The strips *d d'* and d^2 are for discharging and are connected in multiple.

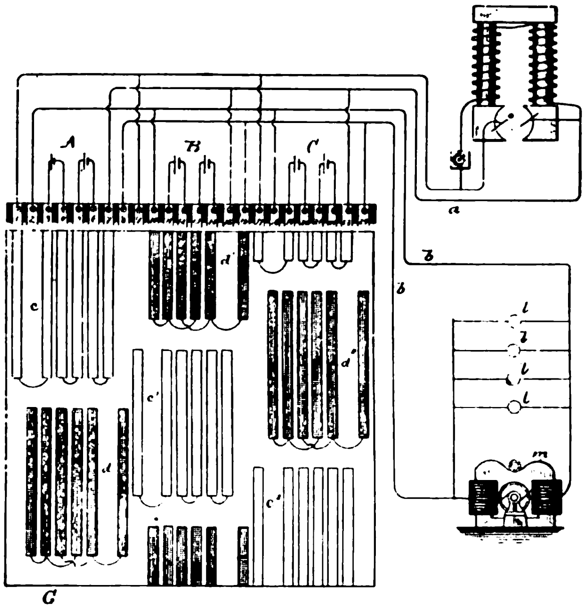

Fig. 1.—Rowland and Duncan's System of Current Distribution.

When the parts are in the position indicated in Fig. 1, it will be seen that the batteries A are connected in series with the charging-circuit by means of the springs bearing on the strips *c*. The batteries C are also connected in series with the charging-circuit by means of the springs bearing on strips c^2. The batteries B are, however, connected in multiple arc with the discharging-circuit by means of the springs which bear on the contact-strips *d'*. It will thus be seen that while the batteries receive a current of high-tension from the charging-circuit they discharge a current of low tension on the consumption-circuit, in which circuit the incandescent electric lamps *l*, electric motors *m*, etc., are placed. When the commutator cylinder revolves, so that the springs leave the strips c^2, the batteries A will still be charging in series while the batteries B are still discharging in multiple arc. The springs will reach the strips d^2 before they leave *d'*, so that for a moment batteries B and C will both be discharged in multiple arc while batteries A are still charging in series, after which the springs will leave strips *d'* and momentarily C will be alone discharging while A is still charging. It will thus be seen that one or more sets of batteries are always in connection with the charging-circuit and one or more sets always in connection with the discharging-circuit, so that neither of these circuits is ever broken.

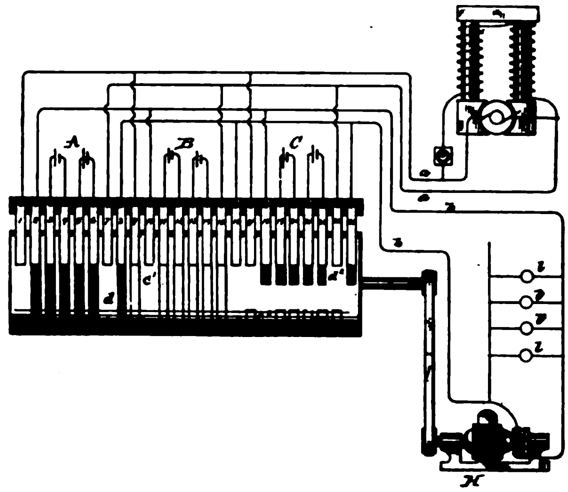

Fig. 2.—Rowland and Duncan's System of Current Distribution.

ON ALTERNATE CURRENT CONDENSERS.[1]

BY JAMES SWINBURNE.

It is, he said, generally assumed that there is no difficulty in making commercial condensers for high pressure alternating currents. The first difficulty is insulation, for the dielectric must be very thin else the volume of the condenser is too great. Some dielectrics 0.2mm. thick can be made to stand up to 8,000 volts when in small pieces, but in complete condensers a much greater margin must be allowed. Another difficulty arises from absorption, and whenever this occurs the apparent capacity is greater than the calculated. Supposing the fibres of paper in a paper condenser to be conductors embedded in insulating hydrocarbon, then every time the condenser is charged the fibres have their ends at different potentials, and a current passes to equalize them, and energy is lost. This current increases the capacity. One condenser made of paper boiled in ozokerite took an abnormally large current, and heated rapidly. At a high temperature it gave off water, and the power so wasted and current taken gradually decreased.

When a thin plate of mica is put between tin foils, it heats excessively, and the fall of potential over the air films separating the mica and foil is great enough to cause disruptive discharge to the surface of the mica. There appears to be a luminous layer of minute sparks under the foils, and there is a strong smell of ozone.

In a dielectric which heats there may be three kinds of conduction, viz., metallic, when an ordinary conductor is embedded in an insulator; disruptive, as probably occurs in the case or mica, and electrolytic, which might occur in glass. In a transparent dielectric the conduction must be either electrolytic or disruptive, otherwise light vibrations would be damped.

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[1] Abstract of a paper read before the London Physical Society.

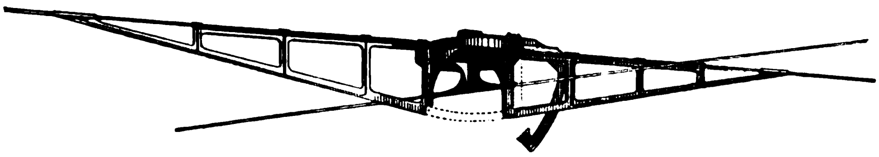
The dielectric loss in a cable may be serious. Calculating from the waste in a condenser made of paper soaked in hot ozokerite, the loss in one of the Deptford mains came out 7,000 watts. Another effect observed at Deptford is a rise of pressure in the mains.

There is, as yet, no authoritative statement as to exactly what happens, and it is generally assumed that the effect depends on the relation of capacity to self-induction, and is a sort of resonator action. This would need a large self-induction, and a small change of speed would stop the effect. The following explanation is suggested. When a condenser is put on a dynamo the condenser current leads relatively to the electromotive force, and therefore strengthens the field magnets and increases the pressure. In order to test this the following experiment was made for the author by Mr. W. F. Bourne. A Gramme alternator was coupled to the low pressure coil of a transformer and a hot-wire voltmeter put across the primary circuit. On putting a condenser on the high pressure circuit the voltmeter wire fused. The possibility of making an alternator excite itself like a series machine, by putting a condenser on it, is pointed out.

THE BAGNALL LIVE TROLLEY CROSSING.

In the erection of overhead trolley wires where the tracks of one company cross the tracks of another, the company first to erect their trolley line will obviously have the right to the most favorable position, that is, the under position. The company last on the ground are required to take the upper position. Their cars are therefore left without current while passing the crossing. The current must be shut off from the motor before reaching the crossing so as to avoid arcing at the crossing gap.

The Bagnall live trolley crossing is designed to avoid this difficulty and maintain continuity of the current to the trolley arm while passing such a crossing. The cut herewith shows a perspective view of the device. To the upper trolley wire is attached a bridge-piece of light lattice casting, at the centre of which is a gap through which the under trolley wire passes. It is attached to, but insulated from, the bridge by means of a disc of insulating material placed in an inverted cup at the centre of the bridge. A curved lever hinged to the upper side of the insulator cup rests by the action of gravity in the position shown in the cut. The passage of a trolley wheel along the wire from right to left will carry the lever along with it and thus bridge over the gap as shown by the dotted ines and thus maintain a continuous connection between he upper trolley wire and the trolley wheel. After the rolley wheel has passed over the gap, the lever is released nd falls by gravity into its former position of rest. The inge and guides of the lever are protected by a hood—not hown in the cut—as a protection against ice.

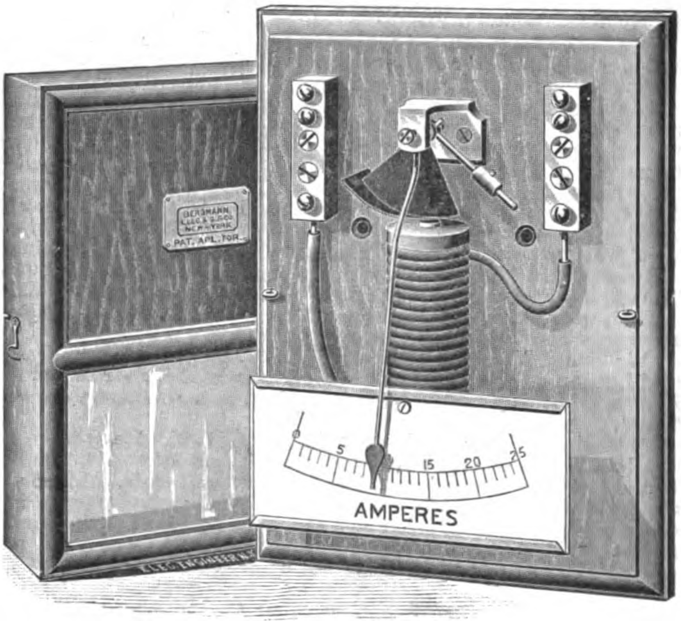


Bagnall Live Trolley Crossing For Electric Roads.

In fixing this crossing in position it is not necessary to ut either of the trolley wires. It is attached directly to he upper trolley wire by means of clips and solder, and e under trolley wire is attached in the same way to its sulator web. In case of slackening or changing in position the trolley wires, the clips can be unsoldered, and the idge moved along in the direction necessary to secure the readjustment, and then soldered again. This ingenious device is being manufactured by the Emerson Electrical Manufacturing Co., of St. Louis.

THE BERGMANN AMMETER.

It has long been recognized that for the proper operation of electric lights circuits, whether arc or incandescent, an ammeter to measure the strength of the current is indispensable, and in order to obtain a form which, while simple and accurate, shall at the same time be reliable and easily read, the Bergmann Electric & Gas Fixture Co. have recently brought out the instrument illustrated in the accompanying engraving. As will be seen, the instrument consists of a solenoid magnet, the core of which acts directly upon a peculiarly shaped armature. The latter consists of a curved and tapered piece of sheet iron, which is mounted on a brass sector, pivoted so as to swing freely. This arrangement is so constituted that the deflections of the armature are practically proportional to the strength of the current and hence equally spaced over the entire range of the scale. Another remarkable feature, which we have had occasion to notice in a test of the instrument, is its remarkable dead-beat quality. This becomes apparent when we consider the fact that the armature is brought in the closest possible contact with the exciting magnet core. For this reason, therefore, the instrument is admirably adapted for portable use, as well as in ship lighting, which requires an instrument which shall not be seriously disturbed by the movements of the vessel. The ammeter is built in sizes ranging from the smallest to the heaviest capacity.


BERGMANN ELEC & GAS F. CO. NEW YORK
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AMPERES

Bergmann Ammeter.

The Belding Motor & Mfg Co., Chicago, are pushing the equipment of their immense new factory to completion with the utmost rapidity, and expect to be installed and turning out a large increased number of their electric motors in the very near future.

MUNICIPAL OWNERSHIP OF GAS WORKS IN THE UNITED STATES.[1]

BY PROF. EDWARD W. BEMIS, OF VANDERBILT UNIVERSITY.

Of the nine cities that now own and operate their gas works in this country, one, Hamilton, Ohio, a city of 20,000 inhabitants, has begun too recently to enable results to be given. The other eight, Philadelphia, Wheeling, W. Va., Bellefontaine, O., Henderson, Ky., and four cities in Virginia—Richmond, Danville, Charlottesville and Alexandria—after a fair trial of many years, have recently refused to entertain good offers from private companies to take the works off their hands. There is most dispute about Philadelphia, which began ownership in 1841, and most foolishly placed the entire control of the works till 1885 in the hands of a self-perpetuating body of trustees; who, being free from responsibility to the people, a primary principle of public finance, naturally abused their powers and became a corrupt body. The bad results finally led to the overthrow of the trust in 1885, and the restoration of the works to public control. Since then, the city management has steadily improved, until in 1889 the cost of over three billion feet of gas, 20 candle power, was only 74 cents per 1000 feet, no allowance being made for interest and the taxes which a private company would have to pay. Allowing five per cent. interest and two per cent. taxes on the cost of duplicating the works, very high figures, the cost of gas would be only $1.02. The city buys some water gas of a private company, but could make it nearly as cheaply if allowed by the legislature to raise money for constructing the proper works.

Richmond, Va., with a population of 87,000, manufactures gas at 76 cents a thousand feet. An allowance of six per cent. for interest and two per cent. for taxes, would raise the cost to only $\$1.04\frac{1}{4}$.

Wheeling, W. Va., with a population of 43,000, does the best of all the cities owning their gas works. Its output of 115,000,000 feet at the burner costs but $43\frac{7}{10}$ and is sold for 75 cents. A liberal allowance for interest and taxes would raise the cost to only 70 cents. Wheeling secures her coal for about 17 cents per thousand feet of gas in the burner. Most other cities in the East have to pay about 20 cents more for coal, but by-products are very low in Wheeling.

In none of the other five cities does the population exceed 15,000, and so the cost of gas is higher; for the cost of gas-making rapidly falls, at least up to 100,000,000 feet a year, with increase in consumption. But all of these cities have done very well. The cost of making, even with allowance for interest and taxes, exceeds $1.33 only in the case of Danville, Va., where coal is five dollars a ton, or over 55 cents a thousand feet of gas in the burner.

In most of the cities owning their own works, slightly higher wages are paid for common labor than in private-owned works, which some may consider a good thing; and there is a tendency toward employing members of the dominant political party. But this has rarely gone so far, especially in recent years, as to affect the positions of superintendents and other skilled officers. The superintendent in Richmond since 1886, was assistant-superintendent for the previous 16 years. The superintendent in Danville has had his office for 16 years; in Henderson, since the city took charge in 1882; in Charlottesville since 1855. In Alexandria, the superintendent now in charge has been out of office only two years in eighteen. Yet, in all these places there have been occasional changes of the party in power.

A study of those fairly representative cities proves the contention of Professor James and others, that in the cities exceeding 10,000 inhabitants, the cost of the entire plant is less than six dollars for every thousand feet sold during the year, and from three dollars to five in most cities of over 50,000. The capitalization much in excess of this common in American cities, and sometimes two to four-fold on which dividends are paid, reveals the monopoly profits of private-owned gas works.

MR. BARTON AND THE "CHRONICLE FIRE TABLES."

Mr. S. E. Barton, president of the Electric Mutual Insurance Co., of Boston, has lately, with very good reason, found fault with the "Chronicle Fire Tables" because they included in electrical fire losses of 1889 the loss due to the big fire in Boston. That fire has not yet been proved in any way to be due to electricity, and as the loss there constitutes 70 per cent. of the alleged electrical fire losses. Mr. Barton is simply discharging a public duty in protesting. He has not received much courtesy at the hands of the "Chronicle," but his last letter on the subject, with a copy of which he favors us, shows he is holding his own gallantly. He has our warmest sympathy in his fight, which aims only to remove from electric lighting a stigma it has not been shown to deserve.

THE SOCIAL SIGNIFICANCE OF STREET RAILWAYS.[1]

BY CHARLES H. COOLEY.

At the fourth annual meeting of the American Economic Association at Washington, December 26-30, a paper upon the above subject was read by Charles H. Cooley, of the U. S. Census Transportation Department. "Rapid transit," said the author, "has hitherto been discussed by economists chiefly in connection with other questions, and therefore in a somewhat desultory and one-sided manner. There is need that street railway transportation should be studied apart from those questions with which it is usually connected, and that an attempt should be made to gain a more adequate and scientific conception of its social functions. This subject will be considered under three heads: (1) It will be attempted to formulate a more comprehensive conception of the function of city transportation; (2) The increasing need of the effective performance of this function will be shown; (3) Various factors upon which efficiency depends will be discussed.

We must recognize in the system of urban transportation a definite social organ having for its function a distribution of population about industrial centres. It is an industrial necessity that men shall work in dense aggregates, while humanity requires that they shall not so live.

The conditions of industrial life are such that the number of aggregate workers necessarily increases relatively to the number of scattered workers. There is, too, a conflict between the industrial tendency to aggregation and the needs of humanity. The function of city railways is to reconcile these conflicting requirements of the social organism. When the social function of rapid transit is clearly conceived, the importance of the efficient performance of that function readily appears. The nearer a condition of ideal efficiency is approached the more possible is it to secure to the poorest classes the conditions of healthful and moral living by increasing the extent to which a given industrial population may be spread out. On account of the rapidly increasing aggregation of population, the need for efficient rapid transit must constantly increase. Two of the factors which enter into the efficiency of city transportation may profitably be considered without the necessity of entering into technical discussion. These factors are the speed of the cars, and the cost of riding. It is found that the distance from their work at which it is possible for those to live who ride to and fro on the cars varies directly with the speed of the cars, but the total area which rapid transit makes available for population varies as the square of the speed of the car. The cost of riding is a very important factor of efficiency because every decrease in fares brings suburban residence within reach of larger classes of the poorest people. A phenomenon which, though incidental to the spreading of population, is yet of first importance, is the influence of rapid transit on city rents. In some cases an actual decrease of rent in thickly settled quarters has been observed to follow the opening of a new suburban railway. It was hardly too much to say that the introduction of electric traction would double the speed and halve the expense of street railways. Although barely three years had elapsed since its practicability for this work was generally admitted, the development since that time had not been equalled in any other industrial branch. He believed there was no engineer who did not look forward to an increase in the effectiveness of all the factors of urban transportation. The influence of a reduction in fares was shown by reference to the experience of the New York elevated railroads where a reduction from an average of $6\frac{3}{8}$ to 5 cents led to an increase of 35,000,000 passengers above the normal increase of 9,000,000 yearly. Rapid transit must not be regarded too exclusively as a source of municipal revenue. The function of spreading population is of co-ordinate importance with any of those now performed by the administrative agencies of cities. Should street railways ever be owned or directly controlled by the public, cheapness and efficiency of service should be considered as of more moment than the obtaining of municipal revenue.

THE NEW TELEPHONE EXCHANGE FOR ALBANY, N. Y.

The Hudson River Telephone Company, it is said, will spend about $200,000 for general improvements to its plant. Its new fire-proof building will be erected at the northeast corner of Maiden Lane and Chapel street. The new structure will have a frontage of 85 feet on Maiden Lane and 23 on Chapel street, will be three stories in height and cost $40,000. On the first floor on Maiden Lane will be the messenger service rooms and the linemen's quarters. On the principal floor, on Chapel street, will be the offices of the manager, assistant manager, bookkeeper and cashier On the second floor will be the operating room, the offices of the president, vice-president and the directors; and on the third will be the necessary appliances for the distribution of the wires, the battery room, etc.

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[1] Abstract of paper read before the American Economic Association, Washington, D. C., Dec. 30, 1890.

[1] Abstract of paper read before the American Economic Association, Dec. 26-30, 1890.

NOTES ON THE CHEMISTRY OF SECONDARY CELLS.[1]

BY PROFESSOR W. E. AYRTON, VICE-PRESIDENT; C. G. LAMB, B.SC., AND E. W. SMITH, ASSOCIATES.

In our paper on "The Working Efficiency of Secondary Cells," read at the meeting of this Institution in Edinburgh in July, it was stated that, "In spite of accumulators with pasted plates having been in use now for nine years, the chemical action that takes place during the different stages of the charge and discharge has only been conjectured, and, odd as it seems, no decisive experiment appears to have been made to settle this much-debated question. Various analyses have been made by different chemists of salts of lead acted on in certain ways with sulphuric acid, but apparently not of actual accumulator plates in action. We are therefore now, with the assistance of Mr. Robertson, making a complete investigation of the chemical state of the plugs of both the positive and negative plates at all stages of the charge and discharge of an 1888 E. P. S. type of accumulator in good condition." The present paper contains an account of the results thus obtained.

The cell selected to remove the plugs from had the same size as the cells employed in the investigations described in the previous communication, and was one of the batch of 50 purchased for the Central Institution about the middle of 1888. Since it first came into our possession it had never been overcharged, never been left discharged, nor permitted to send more than the maximum current allowed by the makers for cells of this size—viz., 10 amperes—and consequently, at the beginning of the present investigation in June of this year, this cell was in excellent condition.

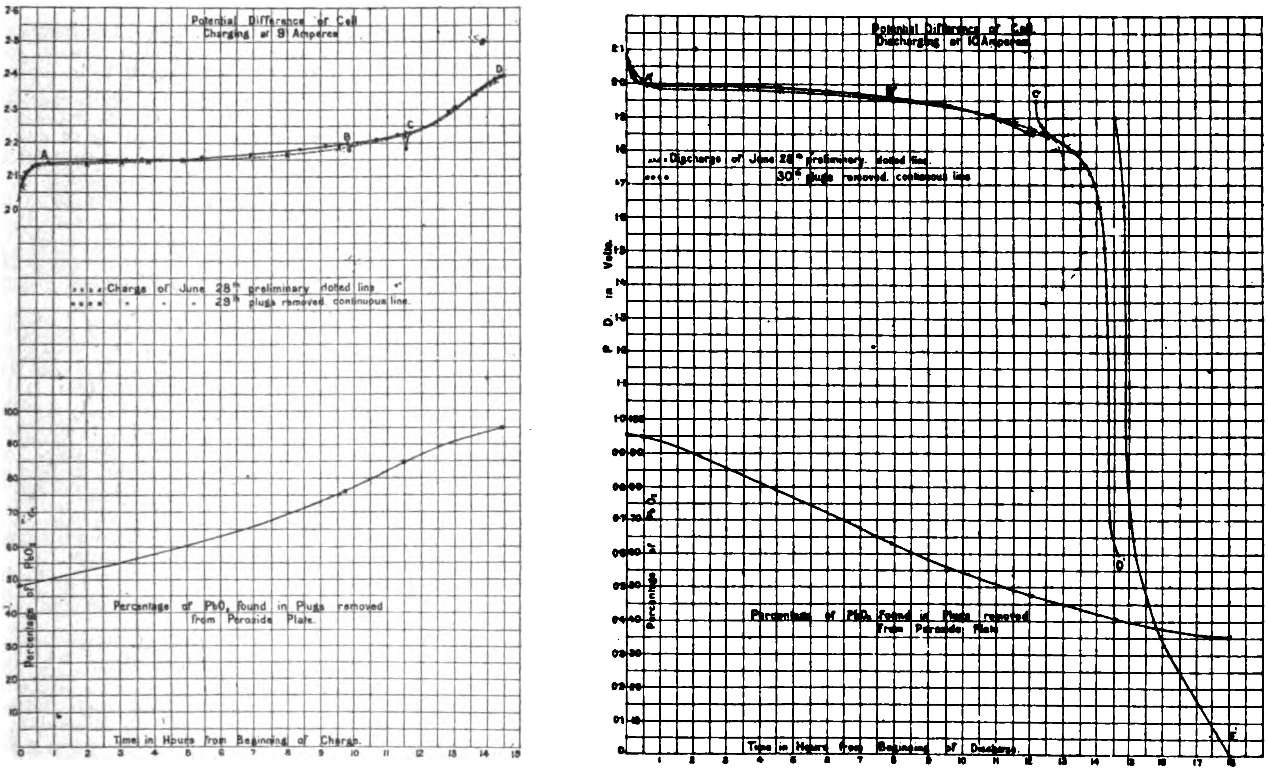
First the cell was several times charged with a current of 9 amperes, and discharged with a current of 10, without stopping day or night, so as to bring it into what we have called its steady "working" state. The dotted curves, Figs. 1 and 2, show the large charge and discharge obtained on June 28th. During the next charge, indicated by the continuous curve, Fig. 1, plugs were removed from both the positive and the negative plates at the points marked *A, B, C* and *D*, when the terminal P. D. of the cell was 2.134, 2.2, 2.284, and 2.4 volts respectively.

After the cell had been charged until the terminal P. D. reached 2.4 volts, it was immediately discharged with a perfectly constant current of 10 amperes, and, as it was anticipated that the removal of the plugs would spoil the cell, it was allowed to discharge far below the normal limit. In previous discharges (the last one of which is shown by the dotted line, Fig. 2), the discharge was stopped when the terminal P. D. fell to 1.85 volts. But in the discharge on June 30th, when the plugs were removed the discharge current was kept at 10 amperes, by using auxiliary cells, until the E. M. F. of the test cell fell to nought, and even reversed. Plugs were removed from both the positive and the negative plates when the terminal P. D. was 2, 1.95, 1.85, 0.6, and nought volts, as indicated by the points *A′, B′, C′, D′*, and *E′*. The recovery of the E. M. F. on breaking the circuit was very marked, especially near the end of the discharge.

The plugs from the top, the middle, and the bottom of each set of plates were at each of the removals of plugs put into six separate bottles, and, to avoid the possibility of error in their subsequent identification, there was noted on the label of each the character of the plates and the position on them from which the plugs were removed, the time, the P. D., and the specific gravity of the liquid in the cell.

Figs. 3 and 4 give an idea of the way in which we found the hardness of the top and the bottom plugs of the positive and the negative plates respectively to vary during a normal charge. The figures are not drawn to scale, as we had no standard of hardness beyond our sensations, hence the figures only profess to be qualitative sketches from which mental pictures can be obtained. Distance measured upways from *O A* indicates roughly the degree of hardness; distance measured downwards the degree of softness.

It will be seen that during the charging the variation in the hardness of the plugs is far greater at the top than at the bottom of the plates, and consistently with this fact Mr. Robertson's analyses show that, on the whole, the rate of chemical action at the top of the plates is greater than at the bottom. The difference in the hardness, however, is far more marked than the difference in the chemical action. For example, while the plugs at the top, on the positive plates are, during the earlier part of the charging, much harder than those at the bottom, no such striking difference is observable in the percentage of lead peroxide contained by these plugs. The cause of this we are examining experimentally at the present time.



FIGS. 1 AND 2.—CHARGE AND DISCHARGE CURVES, STORAGE BATTERY TESTS.

In order to see how far the resistance of the lead grid would tend to make the current-density in the upper part of the liquid less than in the lower, as well as for the purpose of seeing how large a fraction of the whole resistance of the accumulators was due to the lead lugs and to the connections between the successive pairs of lugs, various tests were made from which it appears that the resistance per inch of the lug alone is about 0.000043 ohm: and that the resistance at the contact of two lugs which were tightly screwed together when quite clean, but which have become very dirty from the acid spray falling on them, may be as high as 0.01 ohm, or thirty times the resistance of an inch of the lug itself.

As we have shown in the Edinburgh paper, the mean resistance from positive lug to negative lug of one of these accumulators *complete* is about 0.004 ohm when the contacts between the lugs and the testing wires are made quite clean. Hence it appears that about one-seventh of the whole mean resistance of such an accumulator is caused by the resistance of the lead lugs themselves; and that the resistance of such accumulators as we have been experimenting with can, when joined up in series, be increased by 25 per cent. if the contacts be allowed to become dirty by the acid spray falling on them, even although they remain all tightly screwed up.

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[1] Abstract of a paper read before the Institution of Electrical Engineers.

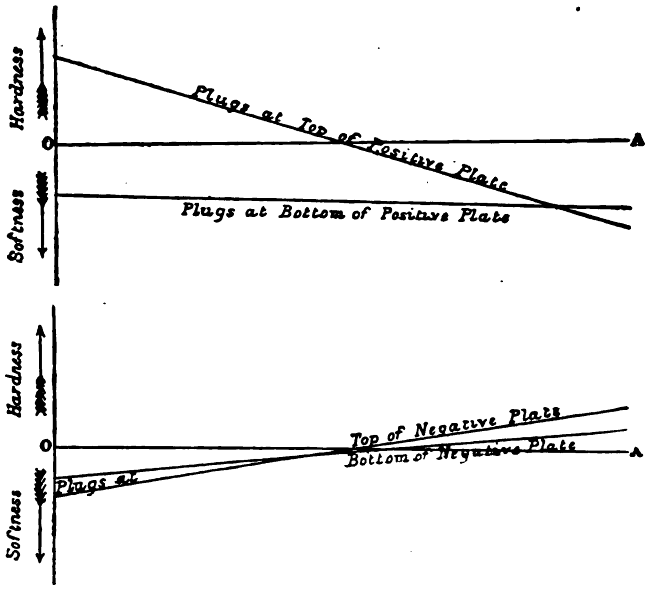
From the mean results of the chemical analysis carried out by Mr. Robertson, we have drawn the curves seen in the lower part of Figs. 1 and 2, and which show the percentage of $Pb\,O_2$ found in the plugs of the positive plate at all stages of the charge and discharge. In the $Pb\,O_2$ curve for charge the first point is obtained from the analysis of the plugs at the end of the normal discharge—that is, when the terminal P. D. had fallen to 1.85 volt, indicated by the point C' in Fig. 2.

The screening influence of lead sulphate is clearly brought out in this curve. Between A and B the surface film and the coatings on the partially reduced granules of $Pb\,O_2$ are got rid of; then between B and C the pure lead sulphate is attacked; and finally, between C and D, with the removal of the last traces we get a very rapid rise in volts P. D.

It was observed that:—

(*a*.) The particles of the peroxide very soon get coated in the discharge with a layer of lead sulphate, which protects the peroxide from further action, as shown by the examination of the dark colored residues which contained peroxide, and which were rendered very hard to dissolve by the coating of sulphate.

(*b*.) The analysis also shows what a large proportion of active material is still remaining at the end of the discharge. This has been remarked on by many experimenters.



FIGS. 3 AND 4.

(*c*.) The loose powdery surface of the positive plate seems to be thoroughly converted into lead sulphate.

(*d*.) When the peroxide in the surface of the plate falls to about 31 per cent. the cell loses its its E. M. F. very rapidly, owing to the inactive layer of sulphate impeding the action of the sulphuric acid on the active material behind it, and also to the formation of peroxide on the negatives. The diffusivity of the acid is decreasing, and it has to penetrate further into the plate to find active material. When the whole of the paste approaches this composition of 31 per cent. peroxide, the cell loses its E. M. F. entirely.

(*e*.) The action seems to take place most rapidly where the current density is greatest; the plate gets hard there from sulphate soonest on discharge, and oxidizes quickest on charge.

If the energy given out by the cell be produced by the conversion of $Pb\,O_2$ in the positive plugs, and of Pb in the negative, into lead sulphate, a constant value of the P. D. at the terminals of the cell when a constant current is passing through it ought to correspond with a constant rate of variation of the percentage of $Pb\,O_2$ in the positive plugs; so that for a constant current

$$\text{the terminal P. D. should} \propto \frac{d\,(Pb\,O_2)}{dt},$$

t representing time. This connection is seen to exist fairly well in the case of the discharge where the slope of the $Pb\,C_2$ curve is roughly constant as long as the P. D. is constant, and acquires a less inclination to the axis of time when the P. D. is rapidly falling. In the case of the charge, the connection between the value of the P. D. and the slope of the $Pb\,O_2$ curve is not so easily seen; but this arises from the fact that towards the end of the charging there is a rapid rise in the resistance of a cell, and therefore in the P. D. required to send a constant current through it; further, the back E. M. F. steadily increases during charging on account of the polarization, which grows larger and larger from the continuous evolution of gas at the surface of the plates.

For the purpose of examining into what took place in an accumulator which was left charged, a small E. P. S. cell was charged until the P. D. was 2.4 volts, and then the positive plates were withdrawn and put into another vessel containing dilute acid of specific gravity 1.2, the negatives being left in the vessel in which they were charged. Both sets of plates were covered up with gutta-percha hoods the edges of which dipped under the liquid, and to the top of each hood was fitted, gas-tight, a vertical graduated glass tube closed at the top. The hoods and the glass tubes were first filled with liquid, and the amount of gas that came off from the two sets of plates was measured from day to day by watching the descent of the liquid in the tubes.

No gas was seen to come off from the positive plates, but in the case of the negatives gas came off very slowly at first, then more rapidly, and finally more slowly again.

The lead of the positive plate was turned into lead sulphate by local action, the 87 c.c. of hydrogen liberated corresponding with about 0.81 gramme of lead turned into sulphate. It is clear, then, that the lead of the negative plate is steadily being turned into some oxide or salt, and probably the loss of energy which we observed in the charged cell left insulated for many days was due to this local action at the negative plate.

CONSTRUCTION AND FORMATION OF E. P. S. PLATES.

The question arises why the E. P. S. accumulators are so constructed that the plugs in the positive plates contain some 48 per cent. more peroxide of lead than is required to be converted into sulphate in the normal discharge. Two explanations suggest themselves. One is that, since the granules of lead peroxide begin, as we find, to be coated with a protecting coating of sulphate early in the discharge, it is impossible, with the present form of plate, for the interior of each granule of lead peroxide to be converted into sulphate, and therefore it is necessary to employ nearly twice as much lead peroxide as is actually needed for the chemical action. Another reason is the fear of the positive plate crumbling to pieces if it be completely formed; and this reason Mr. Capito, who was formerly in the employ of the Electrical Power Storage Co., thinks, on the whole, is the more important.

In the construction of the original Faure accumulators, as well as of the early E. P. S. cells, both the positive and the negative plates were pasted with red lead ($Pb_3\,O_4$), and formed together for a period of some 50 hours. Later on litharge ($Pb\,O$) was used to coat the negative plate, red lead being used only for the positive one, and the plates were formed separately, the negative being much more formed at the works than the positive. Some time ago I was informed by a very competent authority that the following is the modern process of *forming* employed by the Electrical Power Storage Company:—

Positive Plates.—8⅜" by 7⅞" by ¼". Two amperes per plate, or 0.028 ampere per square inch, sent for 18 hours.

Negative Plates.—9" by 9⅝" by 3/16". One and a half to two amperes per plate, *i. e.*, 0.017 to 0.023 ampere per square inch, for 120 hours.

The actual time of forming either set of plates depends greatly on the length of stoppages during the formation. This is especially the case with the negative plates, therefore they endeavor to form the negatives for the 120 hours without any stoppage of the current. On the receipt of a cell from the Electrical Construction Corporation, the purchaser is requested to form it for 40 hours more with the ordinary charging current used in working, which is at the rate of 0.026 ampere per square inch.

The reason, we understand, for the manufacturers only forming the positive plates for 18 hours, and leaving the purchaser to form them for the remaining 40 hours, is that if positive plates be *well formed* and then dried for carriage, the plugs become loose, which is not the case if the positive plates be only slightly formed before drying.

We were interested in learning from Mr. Capito whether, while superintending the manufacture of many thousands of accumulator plates, he had ever tried pasting the positive with lead peroxide ($Pb\,O_2$) in order to avoid the necessity of having to form this salt electrically out of the red lead with which the positive plates are usually pasted. This idea of applying a paste of lead peroxide directly to the positive plate, he told us, he had tried, but that the method turned out a failure, from the impossibility of getting the lead peroxide paste to stick on to the grid even when some red lead was mixed with the lead peroxide. He also mentioned a very interesting fact—that whereas a paste of red lead mixed with dilute sulphuric acid of density 1.1 gives an adherent deposit on formation, on the contrary, a powdery deposit is produced if the density of the liquid used in making the red lead paste be 1.3. We understand the process that has shown itself the best is to use dilute sulphuric acid of density 1.1 for mixing the red lead paste, and dilute acid of 1.2 for mixing the litharge paste for the negative plates.

THE EVOLUTION OF ELECTRIC AND MAGNETIC PHYSICS.[1]

BY A. E. KENNELLY.

THIS address was one of a series treating of the evidences of evolution in the advance of the arts and sciences. It was necessarily and largely of a historical nature, touching in rapid review the various developments in electricity and magnetism as distinct fields and also as subjects that more and more exhibited a tendency to resolve themselves into one effect, under differing manifestations, just as static and dynamic electricity have gradually become identified with each other. The leading conclusions of the address were :

First : In electromagnetic science the great achievement since Faraday's time has been the determination of the fact that all electricity flows or tends to flow in closed curvos or circuits so that we have the electrostatic circuit, the galvanic circuit and the magnetic circuit, each resembling as it were an endless chain or a bundle of endless chains ; and the laws which control these three different types of circuit show wonderful analogies.

Second : The due appreciation of the influence of the ether and its importance in all electromagnetic phenomena. While originally the electrical activity seemed to be confined to the battery or conducting wires of a galvanic circuit, it is now believed that the other surrounding these conductors plays fully as active a part in the process of conduction, so that the mind sees free space no longer void but filled with an active and responsive substance, the ether. Once more in the evolution of thought, the tide of belief has turned, and we hold with Torricelli, under somewhat altered premises, that "Nature abhors a vacuum." The properties of the ether almost threaten to surpass in interest and importance the properties of the matter it environs and pervades.

Third : The evidence in favor of the proposition that light is a vibratory disturbance in the ether of an electromagnetic nature, in such as almost to amount to demonstration. When this shall be generally accepted, the whole domain of optics and radiant energy will be enrolled as one department and property of electromagnetic physics.

Difficult as it is to clearly apprehend the course of evolution in the near past, where events press upon us in narrow bounding throng, and the workers at the great loom of history yet stand by the mesh their hands have helped to weave, how still more difficult it is to guess the future. The prospect that opens is however a brilliant one. We may well believe that in science the same evolutionary process which has united electricity and magnetism, and welded both with radiation, will continue to magnify, simplify, and unify. Contrary to the course of evolution in the organic world, "from the homogeneous to the heterogeneous, the simple to the complex," the development of science is from the heterogeneous to the homogeneous, from the complex to the simple, and just as the evolutionary course of religious belief has been from polytheism to monotheism, so with every fresh acquisition, science becomes greater, and grander, and more succinct.

In arts electricity is destined even apart from future discoveries to take into its own hands the distribution of power. The telegraph has conquered time, and the electric motor is born to triumph over space ; but whether we watch the vibration of the telegraphic recorder that spells its message across the sea, or watch the electric car, urged by invisible hands, pursue its stealthy way, the rhythmic words of Ruskin rise into recollection's sight, "Not in a week or a month or a year, but by the lives of many souls. a beautiful thing must be done."

Letters to the Editor.

A RIVAL TO THE KEELY MOTOR.

Can you get full information from London, or otherwise, in relation to the alleged discovery referred to in cutting herewith? If so would it not be of great interest to your readers? Should you now have, or be able to get, any information on this point I trust you will print it. G. E. TEWKSBURY.

TOPEKA, KAN.

A continental paper, devoted to finance, has the following in a recent issue : "Dr. Mandeuft, of Geneva, has found out a way of producing electricity for nothing. With a half-horse machine he can feed 500 lamps. The apparatus is made up of a hollow sphere of zinc of 50 cm. diameter, and a massive sphere of copper 40 cm. diameter. The copper revolves inside the zinc sphere, and the two revolve at the same time, but in opposite directions, at the rate of 500 revolutions a minute. Steam at a pressure of six atmospheres is delivered into the gap between the spheres and a current is produced, the pressure of which may be increased by increasing the revolutions and the steam pressure. Trials made in London with M. Mandeuft's new machine are quite bewildering the scientific world."

[While Dr. Mandeuft, whoever he may be, should find no difficulty in running 5 lights from a ½ h. p. machine, he certainly could never run 500 ; and the statement as to the 500 lights discredits the whole story, even if it were not otherwise open to suspicion. Dr. Mandeuft may possibly get either a chemical-electric, a thermo-electric or a mechanical-electric effect from such an apparatus, but we should not expect to obtain very much under the conditions enumerated.—EDS. E. E.]

European Correspondence.

LONDON.

The Progress of Electric Lighting in London.

I MENTIONED in my last letter that Mr. Bailey was down for reading a paper before the Society of Arts on the progress of electric lighting in London. It was read before a goodly muster of Fellows under the presidency of Sir Frederick Bramwell. Although showing signs here and there of hurried compilation, it is undoubtedly the most authentic record of the complete work done in London, and, as Prof. Kennedy said at the time, it will be much quoted at a subsequent period. The lecturer in his opening remarks said that the electric lighting Act of 1882, though stifling inordinate speculation on the part of the public, had the effect of checking any advancement of electric lighting. After giving a general description of the stations in work, interesting figures were advanced. From these I gathered that the total equivalent number of 32 watt lamps, now in use in London, is approximately as follows : Public companies supply 179,060 and private plants work 85,000, which gives a total of 264,060, and the present rate of increase shows an addition of at least 4,000 lamps per week. Arc lamps are not very successful in figures, for the total does not go far beyond a thousand.

The lecturer thought it was a regrettable matter that there had not been any progress in the efficiency of the incandescent lamp. The future progress of electric lighting depended in no small measure on the lamp makers, and as the manufacture of the incandescent lamp would soon be open to all, the absolute necessity of a standardizing laboratory must compel its adoption where not only instruments but lamps could be tested.

In the course of the discussion which followed the reading of the paper, Mr. Bailey said, so far as he could ascertain there were now 81¼ miles of conduits of all kinds into which were laid about 111 miles of cables which were actually carrying current at the present moment. This had been completed in about eighteen months.

Referring to overhead lines, there were in London about 25 miles, and he had not heard of a single accident due to them. The prejudice which existed against them was due to the wretched work done in New York, where they neither properly suspended nor insulated their wires.

Sir F. Bramwell considered that the large number of private installations compared with public ones was due entirely to the baneful clauses of the original act.

Mr. R. E. Crompton thought electrical engineers ought to feel proud that though they had been so heavily handicapped in the race, they had begun at last to bring London to the front, and it would not be long before they would be as far ahead of any other town in the world in electric lighting as they were in most other respects.

Prof. Kennedy, F. R. S., said, in his opinion there was no other city in the world which had 250,000 lights. He believed it was about double the amount in use in New York, and before long people will be coming here for information instead of scoffing. With regard to safety in working a station, there should always be power in reserve equal to one of the largest units; if 200 horse-power engines were the largest used, for instance, there should be 200 horse-power in reserve.

Prof. Forbes said he had taken pains to learn what was being done in other countries by personal inspection, and had frequently on his return from such inquiries done his best to impress on those concerned at home, the superiority of the work done abroad. The last time he had occasion to do so was about three years ago, when hardly any of the work now described had been commenced, but he now concluded that there was not an example in the whole world of such enormous progress in so short a time.

H. S.

LONDON, Dec. 17, 1890.

Home Correspondence.

CHICAGO.

A New Submarine Boat.—Fire in the Calumet Station.

THE Detroit Boat Company is constructing a submarine craft which is expected to achieve remarkable results. The vessel is 40 feet in length, 9 feet beam and 14 feet deep. The mechanism is similar to that used in submarine torpedo boats.

Electric storage batteries will be employed for furnishing the necessary motive power and giving light. The improvement over the torpedo boat is claimed to be the buoyancy of the craft, which will rise to the surface as soon as the electric motor is stopped, whereas in the torpedo boat the machinery must be working to bring it to the surface of the water. In addition to a screw at the stern, there will be two wheels on either side of the new vessel. By simply turning an electric switch the boat will immediately rise or plunge deeper in the water. It is being constructed as a pleasure boat, but if it proves as successful as expected, the government will be requested to consider its adoption as a torpedo boat.

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[1] Abstract of address before the Brooklyn Ethical Association, Dec. 28, 1890.

A disastrous fire occurred last week in the power house of the Calumet Electric Light Company near South Chicago avenue and 95th street. On the alarm being given, eight engines arrived upon the scene, and the firemen found a lively fire rendered especially dangerous from the fact that the station stands in close proximity to the gas house and tanks of the Chicago Gas Company. For some time it was thought the gas works would catch in spite of the efforts of the firemen, but fortunately this did not occur. The origin of the fire is unknown, and the loss has not yet been estimated. The lights went out shortly after the fire commenced, and it is thought the valuable machinery is damaged beyond repair.

CHICAGO, Jan. 1, 1891.

Society and Club Notes.

THE NEW YORK MAGNETIC CLUB.

Mr. George F. Fagan, secretary, gives notice that the annual (business) meeting of the Magnetic Club will be held in Room 29; at 195 Broadway, on Thursday, the 8th of January, 1891. at 4.30 o'clock. p. m., for the election of officers and four members of the Governing Committee, and such other business as may properly come before the meeting. The date of holding the next social meeting is under advisement of the Governing Committee, and will be announced soon.

NEW YORK ELECTRIC CLUB.

The weather was stormy and gloomy on New Year's day, but within the hospitable doors of the Electric Club reigned an atmosphere full of sunshine and jollity. The muster of those who wished to welcome in the new year with good fellowship was large, and the club walls have never before listened to so much hearty laughter or to so many really new stories. The noble punch bowl presented by Col. H. R. Garden was duly brought out and honored, not in the breach but in the observance, and the task of the punch-brewer proved so onerous that he still doubts whether January 1 can be called a holiday.

Appointments, Etc.

MR. C. K. MINARY, of Louisville, Ky., succeeds Mr. N. McD. Crawford as manager of the electric railway at Rochester, N. Y.

MR. W. WEBER, of the Louisville, Ky., Adams Express office has been offered the secretaryship of the Consolidated Electric Light and Gas Heating Co. to succeed Mr. F. Poindexter.

MR. W. H. MCCLURE has been elected city electrician of Worcester, Mass., in the place of Mr. C. M. Mills.

MR. JOSEPH E. LOCKWOOD has been presented with a chain and charm on the occasion of his retirement from the managership of the Brush station in Detroit. Mr. H. L. Wilton succeeds him.

MR. JAMES NORTHLEY, formerly of Charlotte, N. C., is now in charge of the Asheville telephone exchange. Mr. J. S. Bixby is with the exchange at Charlotte.

MR. W. M. BESSON, the superintendent of the Bell Telephone Co. at Cincinnati, is dead. Resolutions of regret and sympathy have been adopted by the employés.

MR. D. HARRIS has been succeeded by Mr. Yarnall as superintendent of the Haverford, Pa., Electric Light Co.

GEN. E. H. BROADHEAD, of the Wisconsin Telephone Co., Milwaukee, died Sunday, Dec. 14.

A LARGE ELECTRIC MINING CONTRACT IN PENNSYLVANIA.

The contract for what will be the largest electric mine haulage plant has recently been given to the Edison General Electric Co. by the Loyalhanna Coal and Coke Co., of Philadelphia. This plant will consist of one locomotive, capable of delivering hourly 120 mine cars to the bottom of the shaft, each car containing 2½ tons of coal. This would make the output 300 tons of coal per hour and a total work of 375 ton miles per hour; the gross weight of the trains to be hauled will be 120 tons. About 3,000 lineal feet of gangway will be equipped with conductors at the start, but as the gangways are extended this will be increased to 10,000 feet, and it is then expected to put in a second locomotive of equal capacity with the one mentioned above.

Reports of Companies.

SKOWHEGAN, ME., ELECTRIC LIGHT COMPANY.

At the annual meeting of the Skowhegan Electric Light Company, Ed. P. Page, A. H. Weston, C. A. Marston, William Duran, of Skowhegan, and S. B. Paine, of Boston, were elected directors; A. R. Bixby, treasurer; M. B. Heselton, clerk; George Cushing, auditor. The treasurer's report showed the receipts for the year to be $16,392.39; running expenses, $8,277.30, making the earnings on the stock nearly 16 per cent., 5 per cent. of which has been paid to stockholders. There is about $1600 in the treasury, the balance has been paid out for improvements made upon the plant. The company are now running about the full capacity of their plant. They have lately closed a contract with the county-commissioners to light the county jail at Norridgewock for one year.

ELECTRICAL INTERESTS IN MILWAUKEE.

Owing to the consolidation of the Villard properties in Milwaukee, Superintendent Linn, of the Cream City Street Railway, will retire, and Superintendent Hommel, of the Milwaukee City Company will assume managerial control of the consolidated corporations. The officers of the new corporation are as follows: Henry Villard, president; Henry C. Payne, vice-president; directors, Charles L. Colby, Colgate Hoyt and W. J. Curtis, of New York; Frank G. Bigelow, of Milwaukee, and David S. Wegg, of Chicago.

THE NARRAGANSETT ELECTRIC LIGHT CO., OF PROVIDENCE.

A proposition will be brought before the stockholders of the Narragansett Electric Lighting Company, at a meeting to be held Jan. 14, that new stock to the amount of $200,000 be issued at par and offered to the stockholders and certificate holders in the proportion of one share of new stock for every three shares or certificates of outstanding stock.

This will enable the company to retire its floating debt as it matures, and leave a surplus for improvements. The total amount of outstanding stock is now about $400,000.

THOMSON EUROPEAN ELECTRIC WELDING CO.

Francis Peabody, Jr., treasurer of the company, in a circular says:

"Seventy thousand pounds have been received from the City of London Contract Corporation by the Thomson European Electric Welding Company. Of this amount £10,000 were paid as a forfeit because the contract corporation failed to buy the continental patents within the time for which that corporation had an option, and £60,000 have been paid on account of the purchase of the British patents. There is still to be paid by the contract corporation, as purchase money for these British patents, £40,000 in cash, 400 founders' shares and one-third of the ordinary shares of the English Electric Welding Company (limited), before our company assigns the patents to that company. Owing to the bad state of the money market in London, it has been absolutely impossible for the contract corporation to bring out the British company with a fair prospect that the shares would be subscribed for, and it has been agreed that the time for paying the balance of the purchase money and bringing out the company shall be extended until Feb. 28, 1891. Meanwhile, the money already received, less the expenses, has been deposited in a trust company in Boston upon interest, while the balance of cash unpaid, £40,000, is also drawing interest from the contract corporation."

The patents for other European countries are still in hand to be disposed of, and sooner or later will bring valuable returns.

THE CONSOLIDATION AT PLAINFIELD, N. J.

The Plainfield Gas and Electric Light Company organized Dec. 30, by the election of the following officers: President, E. R. Pope; secretary and treasurer, H. G. Runkle; directors, Wm. Runkle, H. G. Runkle, and E. R. Pope. This new company has leased the entire plant of the Plainfield Gaslight Company and has puchased outright the Plainfield Electric Light Company's works, thus securing a complete monopoly of public and private lighting. The company promises a better service and a material decrease in the cost of illumination to consumers.

BELL TELEPHONE OUTPUT.

The Bell Telephone output for month ended Dec. 20 was 5542, a gain of 532. Returned, 3171, a gain of 1031. Net, 2371, a decrease of 499. Jan. 21 and Dec. 31 output, 64,647; increase, 748. Returned, 27,878; increase, 2911. Net, 36,769; increase, 4569.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED Dec. 30, 1890.

Accumulators :—

Secondary Battery. H. H. Wardwell, 443,556. Filed Sept. 2, 1890.

The plate or electrode has cavities formed in it, each cavity being open at one side of the plate and having a bottom at the other side for the retention of active material ; a reticulated or lattice-work cover, having enterstices opposite each of the cavities, is secured upon each side of the plate or electrode.

The patent further includes details of the construction of cells or battery cases and of the means for connecting the electrodes in series in each cell and for connecting the cells together in batteries.

Alarms and Signals ;—

Electrical Fire-Alarm and Extinguishing System, C. E. Ongley, 443,724. Filed Apr. 12. 1890.

The invention relates particularly to protective systems in which thermostats are distributed through buildings to be protected and the circuits are led to the office or other suitable point at which is located apparatus arranged to be released by the operation of the thermostats and to record or signal automatically the number or location of the particular thermostat from which the alarm has arrived, and which thermostat will have released sprinkling apparatus for the extinguishment of fire. The special object of the present invention is to provide a signal or alarm to indicate an accidental breaking or disarrangement of the automatic sprinkler and to secure the prompt closing of a water valve or valves upon a false alarm from the thermostat. Provision is also made to secure non-interference between different classes of signals.

Non-Interfering Signaling System. C. E. Ongley, 443,725. Filed May 9, 1890.

Improvements in apparatus for use in fire-alarm, fire-telegraph, hotel annunciator and other similar systems in which it is required to send distinct signals from several points to a common receiving station. The invention is chiefly directed to securing the non-interference of signals from different boxes.

Electrical Signal System, C. E. Ongley, 442,726. Filed May 13, 1890.

The object of the invention is to provide means by which a signal receiving device having a number of operating magnets may be operated over a single line wire, either of the electro-magnets of the receiver being actuated at will from the transmitting station. The two or more operating magnets of the receiving apparatus are in separate local circuits or branches; an automatic distributor or switch, driven by a motor is employed to control the selection of the proper local circuit by the signal from a transmitting station.

Watchman's Electric Time Recorder, C. E. Ongley, 443,787. Filed Jan. 20, 1890.

Employs time printing type-wheels controlled by a clock movement, printing mechanism and an electro-magnet controlling the printing mechanism, and a number-printing type wheel controlled by a second and independent electro-magnet.

Watchman's Electric Time Recorder, C. E. Ongley, 443.788. Filed March 17, 1890.

Amplification of the system disclosed in No. 443,787, above.

Electric Protective and Signaling System, C. E. Ongley, 443.790. Filed Nov. 26, 1889.

A general system of electrical circuits and apparatus for large buildings, such as factories and hotels, to provide a system of indications or signals at a central point from various parts of a building and for various purposes, such as watchman's time-signals, with permanent record, indications of the time of starting and stopping of engines, fire alarm signals, with provision for the automatic control and operation of fire-extinguishing apparatus.

Electrical Annunciator, J. W. Luthe and A. E. Jeavons, 443.834. Filed Jan. 23, 1890.

The electro magnets of an annunciator are constructed as induction coils, with primary and secondary windings. The primary windings are exterior and are connected to battery and call-bell on the one side, and to the various push-buttons on the other side in multiple arc, in the usual manner. The secondary windings, immediately upon the cores of the magnets, and which directly actuate the pointers, are connected in series throughout.

Conductors, Conduits and Insulators :—

High Resistance Compound. W. G. Bremer, 443,497. Filed June 6, 1890.

Consists of graphite and shellac.

Art and Means for Covering and Insulating Wire, T. W. Norman, 443.536. Filed April 29, 1890.

Consists in treating the insulated wire so as to render it proof against burning or damage by contact for a few seconds with molten metal ; the insulated wire is passed centrally through a chilling mold and molten metal is poured around it as it is fed through the mold.

Machine for Covering Electrical Conductors with Lead, F. H. Stillman, 443.551. Filed June 6, 1890.

Claim 1 follows :

The combination, with a die-block having a lead-chamber formed therein and openings for the core-bar and die, of a sleeve supported within the lead-chamber in proper relation to the die, and a hollow core-bar seated in said sleeve.

High-Resistance Compound, W. G. Bremer, 443,565. Filed Oct. 31, 1890.

Claims 1 and 2 follow :

1. A homogeneous high-resisting composition or compound consisting of rubber, shellac and graphite, substantially as and for the purposes described.

2. A homogeneous high-resisting composition or compound consisting of rubber, sulphate of baryta, graphite and shellac, substantially as and for the purposes described.

Apparatus for Laying Electric Conductors, T. J. Cope, 443,823. Filed May 22, 1890.

Employs a projectile, propelled by compressed air, to convey a wire or cord through a conduit. The patent covers special devices for operating such a system.

Apparatus for Laying Conductors in Conduits, T. J. Cope, 443,821. Filed Sept. 4, 1890.

Consists of an apparatus for conveying a wire or cable through a conduit having a head, a tail piece, a carrier and guiding rods. The entire apparatus moves through the conduit and is advanced by successive motions controlled by ropes extending from its rear to the man-hole or other point of insertion. The mechanical construction of the device is such that the pulling of one rope effects the clamping of the tail piece against the sides of the conduit while advancing the carrier with the wire or conductor ; and the pulling of the other rope clamps the carrier in like manner and advances the tail piece.

Dynamos and Motors :—

Electric Motor, C. J. Van Depoele, 443,980. Filed March 8, 1889.

Motor especially adapted for alternating, intermittent or pulsating currents ; intended, among other things, to obviate the necessity of synchronism between the armature speed and that of the generator supplying the current for efficient action on the part of the motor, and thus to enable motors to run with efficiency at low speed or in starting a load—as, for example, in electric railway work. The armature, preferably of the ring form, continuously wound, has conductors extending across at right angles with each other and electrically uniting diametrically opposite portions of the armature conductor to form two or more closed circuits therein. In large armatures more than two such cross connections may be used to advantage. In addition to the usual field magnets the armature is surrounded by a separate stationary electro-magnetic system for producing magnetizing currents therein by induction and thus establishing poles in the armature core. The non-rotating induction coil surrounding the armature may be made adjustable with respect to the poles of the field magnets.

Galvanic and Thermo-Electric Batteries :

Galvanic-Battery, G. A. Smith. 443,976. Filed July 14, 1890.

Design and construction of a battery cell containing one or more rods of zinc and one or more rods of carbon, with mechanism for plunging and lifting the elements and for holding them at any desired height.

Lamps and Appurtenances :—

Socket for Electric Lamps, C. A. Lieb. 443.530. Filed Sept. 24, 1890.

The socket it is made of one piece of non-conducting material, which should be water-proof, and has cast in it or otherwise embedded, the conductors, holding them in place without the aid of screws or other fastenings. It is intended to avoid all short circuiting by water, snow or ice ; the conductors are located within a hermetically sealed chamber.

Incandescent-Lamp Socket, S Bergmann, 443,562. Filed Jan. 10, 1890.

Construction and arrangement of parts designed to secure simplicity and to obviate the twisting or abrasion of the circuit-wires by the outer shell.

Arc Lamp, A. W. Whitcomb, 443,557. Filed March 27, 1890.

Relates to the class of arc lamps in which the upper carbon is lifted to strike the arc by the action of an electro-magnet in the main circuit and is fed by the action of gravity controlled by gearing. There are two releasing devices for the feeding mechanism, one actuated by the main current and the other by a shunt current, each independent of the other.

Shade-Holder for Incandescent Lamps, S. Bergmann, 443,563. Filed Jan. 25. 1890.

The shade-holder has segmental sections elongated in the direction of the length of the socket and concentric throughout their extent, forming a tubular collar.

Switch, E. H. Johnson, 443,606. Filed Jan. 21, 1885.

Designed to control the separate circuits of several electric lamps or groups of lamps by a single apparatus, and adapted to throw the lamps or groups of lamps successively into or out of circuit, so that one or all or any intermediate number of the lamps or groups may be lighted or extinguished.

Lamps and Appurtenances.

Electric Street-Light. G. M. Kim. 443,097. Filed May 19, 1890.

A design and construction of a mast arm for electric street lights.

Electrical Signaling Apparatus, A. B. Wyckoff, 443,157. Filed May 5, 1890.

The invention consists in devices for flashing an electric light for signaling or other purposes. For a lamp or group of lamps there is provided a rotating shaft having projecting arms in different planes, and segments, one for each arm, one segment serving to direct the current to the lamp or lamps and the other segment shunting the current back to the dynamo. The object is to flash the lamp instantly up to its full power and to extinguish it instantly.

Circuit Breaker and Closer. J. S. Potter & D. J. Cartwright, 443,401. Filed Aug. 16, 1890.

Design and construction of circuit-breaker and closer particularly adapted for the key-sockets of incandescent electric lamps.

Gas and Electric Lamp Fixture, C. Felton, 443,487. Filed Dec. 23, 1889.

A device for securing the canopy of a gas or electric light fixture in position through frictional contact.

Electric-Arc Lamp, E. Heymann and F. W. Heymann. 443,632. Filed Nov. 5, 1888.

The feed rod is of magnetic metal ; an electro magnet having shunt and main windings has its core mounted axially and extending across the feed rod and carrying a pole-piece the magnetism of which controls the feed rod ; one or more pole-pieces act with a second magnet to move the controlling magnet on its axis.

Electric Arc Lamp, E. Heymann and F. W. Heymann, 443,633. Filed Nov. 5, 1888.

Regulator consists of two electro-magnets controlled by shunt and main currents ; their cores are mounted axially cross-wise of the feed rod, the pole pieces of the cores forming rocker-arms and the feed-rod being gripped directly between two opposed pole-pieces.

Electric-Lamp Socket, J. T. Dempster, 443,743. Filed May 24, 1890.

Designed for simplicity and permanence of adjustment. The circuit is complete independently of the outer sleeve, there being no electrical connection between the exposed portions of the socket and the screw threaded sleeve into which the lamp base is affixed.

Attachment for Electric-Arc Lamps, A. Manning, 443,944. Filed Sept. 24, 1890.

A guide for securing the alignment of the two carbons.

Electric Switch, J. J. Wood, 443,693. Filed May 28, 1890.

For closing or opening circuit, or for throwing in or out a loop. Especially adapted for use on lighting circuits. A "quick-action" or "snap" switch. Consists in a new mechanical movement for switches of the class in which the actuating device acts first to store up the power required to throw the switch—as, for example, a spring—and then by its further movement to bring the stored power into action to throw the switch instantaneously.

Measurement :—

Apparatus for Measuring and Registering Electric Currents, C. A. Faure, 443,636. Filed Nov 1, 1888.

A motor-meter, based upon the principles that a conductor conveying a current tends to rotate in a magnetic field ; employs a rotary non-commuting electric motor to actuate the registering mechanism.

Electric Meter, C. P. Elieson, 443.612. Filed March 18, 1890.

An electrolytic meter ; provides for ascertaining the quantity of current which has passed in a liquid, either by measuring the volume of gas generated or by registering the pulsations caused by the accumulation of gas as it is generated. In connection with the latter method there is provided a mercurial trap which permits the flow or escape of gases at intervals only when a definite pressure has been obtained.

Metal Working:—

Methods of Electric Soldering and Cementing Cans, M. W. Dewey, 443,748. Filed Oct. 4, 1890.

Adaption of electric heating to the processes of soldering and sealing cans; designed especially for application to capping machines now in use without material alteration in their construction.

Apparatus for Electric Soldering and Cementing Cans, M. W. Dewey, 443,749. Filed Oct. 4, 1890.

Amplification of the devices of patent 443,748 above.

Medical and Surgical:—

Electrical and Vapor Face-Bath. N. Lyke, 443,580. Filed Apr. 25, 1890.

The pan of a vapor face-bath is provided with detachable electrodes.

Miscellaneous:—

Apparatus for Preventing Steam Boiler Incrustation, J. Langstaffe, 443,598. Filed Feb. 10, 1890.

A disc of finely divided material secured between a positive and a negative electrode is suspended in the water space of a boiler. The theory of the invention is that an electric current is generated by the impure water between the positive and negative electrodes, and that the impurities are deposited upon the disc of finely divided material.

Magneto-Electric Stop Mechanism, W. H. Kilbourne, 443,646. Filed June 4, 1890.

Magneto-electric apparatus designed for use in factories, and like places, by which the supply of power to machinery may be stopped instantaneously from any point in a building. A belt-tightner or "idler-pulley" is shifted through mechanism controlled by an electro-magnet.

Electric Stop-Motion for Warping-Machines, P. Goldschmidt, 443,674. Filed Jan. 11, 1890.

A warping or similar machine is provided with a dial for indicating the number of yards of thread being wound and electro-magnetic devices for actuating a stop-motion. The creel is provided with faller-wires adapted to close the electric circuit upon the breaking of a thread.

Electric Damper-Regulator, J. O'Meara, 443,716. Filed May 2, 1890.

Employs the expansion of German silver wires, or equivalent electric conductors, under the passage of a current for operating the controlling devices in one direction and the contraction of the conductors when the current is cut off for operating the devices in the opposite direction.

Safety Device for Dynamo Stations, C. E. Ongley, 443,727. Filed June 30, 1890.

Designed to shut off current when a fusible cut-out or other safety device in a dynamo-circuit has burned out and an arc has been formed. Provides for the stoppage of any one dynamo in a station, and in extreme cases for the stoppage of the engine; also controls the operation of sprinklers or fire extinguishers.

Electro-Magnetic Clutch, C. E. Kells, Jr., 443,772. Filed March 31, 1890.

Applies to a power driven shaft a wheel or pulley loosely mounted thereon, an electro-magnet and its armature, connection between the armature and the wheel, a retractile spring for the armature, a friction block with which the wheel engages when the armature is withdrawn from the magnet, and a friction collar with which the wheel engages when the magnet attracts the armature.

Electric Valve-Controller, C. E. Ongley, 443,789. Filed April 4, 1890.

Electro-magnetic device for the control of a comparatively large valve which is moved by fluid pressure through the agency of a second valve; the second valve being actuated by an electro-magnet.

Railways and Appliances:—

Pole-Top for Trolley-Wire Supports, W. Le R. Emmet, 443,508. Filed Sept. 18, 1890.

First claim follows:

The combination of a metal pole, a plug or block of insulating material attached to the upper end of said pole, a hollow metal top resting upon said plug or block and inclosing a portion of the top of said pole, and a sleeve of insulating material inserted between said pole and said top.

There is also described an out-rigger made of two metal rods bolted together, the rods bowed out at one end to clamp the whole.

Apparatus for Automatically Grounding or Cutting Out of Circuit Exposed Electrical Conductors, F. W. Jones, 443,527. Filed Aug. 15, 1890.

Especially applicable to the conductors of electric railways. Along with a continuous main line conductor there is provided a guard wire having earth connections at stated intervals and circuit-controlling devices normally open and adapted to become operative upon the breakage or falling of the main conductor.

Traction and Brake Device for Electric Railways, R. M. Hunter, 443,661. Filed Sept. 23, 1886.

Consists essentially of a helix upon a hollow iron core and adapted to embrace or surround the lower part of the wheel of a railway car. Intended to magnetize the wheels and thus increase traction; intended also to act as a brake when brought into contact with the wheels.

Electric Locomotive, R. Eickemeyer, 443,671. Filed Jan. 28, 1869.

Application of the inventor's "iron-clad" type of motor to railway cars, and including special methods of attaching the motor to the car and of transmitting the power from the motor to the car axle.

The shell or casing of the motor, which constitutes a part of its magnetic system, serves also as a magnetic shield between the interior of the car or locomotive and the magnetic field of the motor, protecting watches or other property of passengers from exposure to magnetization. The motor is suspended directly from the under side of the sill-framing of the car. The armature shaft of the motor is operatively connected with the axle of the car by means of pitmen connecting the motor shaft with a counter-shaft occupying the same vertical plane as the axle and carried thereon, but coupled by links or frame pieces hinged to the motor on bearings concentric with the motor shaft. The counter shaft is so geared to the axle that the meshing point of the gears is in the vertical plane of the counter shaft and axis.

Traction and Brake Device for Electric Railways, R. M. Hunter, 443,677. Filed Sept. 23, 1886.

Similar to No. 443,661, above.

Electrical Attachment for Railway-Switches, A. W. Berne, 443,814. Filed July 5, 1890.

Electrical apparatus providing for ringing a bell in the cab of a locomotive when a train is approaching a switch which has been misplaced.

Telephones and Apparatus:—

Telephone, S. Bergmann, 443,493. Filed Dec. 31, 1884.

Claim 2 follows:

The method of reproducing articulate speech from telephone-current vibrations, consisting in passing the electric current axially through a magnet, thereby varying its force in conformity with the current changes and moving a sound-producing body by the varying force of such magnet.

Telephone, S. Bergmann, 443,494. Filed Oct. 26, 1885.

In a telephone transmitter, in place of the ordinary button and stud contacts the inventor employs two metal rods making end contact, one of them attached to the centre of the diaphragm and the other held rigidly in place in the frame of the instrument. The contact points of the rod may be formed of platinum, and the rods may be magnetized steel. Such magnetized steel rods are specified in claim 2.

Telephone, E. H. Johnson, 443,526. Filed April 24, 1884.

A telephone transmitter in which variations of current strength are obtained through the impingement of the diaphragm upon a greater or less number of contact points or electrodes connected to definite units of resistance located in shunt circuits around the electrodes.

Legal Notes.

DECISIONS AS TO THE DUTY ON ELECTRICITY AND NATURAL GAS.

The Treasury Department, at Washington, through Assistant Secretary Spaulding, has recently made two decisions which have attracted a great deal of attention from those interested. Recently a clerk of customs of one of the ports of the Texas border made inquiries of the department as to the tax which should be assessed against a certain electric company which was wiring its electricity across the Rio Grande into American territory. Secretary Spaulding decided that inasmuch as electricity is intangible and as he puts it, cannot be measured, electricity might come in free.

About the same time Clerk Morgan, of Buffalo, inquired how he should treat the importation of a certain company in Buffalo who had made arrangements to bring natural gas across the Niagara river from Canada into the United States through the medium of an eight-inch pipe.

In this case the Treasury Department prepared a decision which the assistant secretary signed, in which he holds that natural gas is an unmanufactured product not otherwise provided for, and is therefore dutiable at the rate of 10 per cent. ad valorem. The manufactured product electricity can be brought into the United States free under this decision, but the unmanufactured natural gas from which electricity could be produced is taxable at the rate of 10 per cent. The Buffalo concern, if it desires to evade this 10 per cent. tax, can turn its gas fuel into an electric current on the Canadian side of the Niagara river, and carry it across the river through wires instead of pipes. This they can do under Assistant Secretary Spaulding's decision, without regard to customs laws.

SUIT FOR DAMAGES TO TELEPHONE CIRCUITS BY THE ERIE, PA., ELECTRIC ROAD.

The New York and Pennsylvania Telephone Company has begun an action against the Erie Motor Company in the Court of Common Pleas for trespassing, laying damages at $50,000. The telephone people allege that the Motor Company's wires have damaged the value of their franchise, and that by induction the telephone service in Erie has been greatly damaged. The right to claim damages is attached to priority privileges. The Telephone Company claims to have expended large sums of money to correct the interference, but without avail.

Metal and Supply Market.

CONFERENCE OF THE WIRE MILLS.

A special dispatch from Pittsburgh, of Dec. 31 says: "A conference of wire manufacturers is in session here, the subject being to devise means of curtailing the output of the mills and to advance prices. It is denied that a trust is in contemplation. The manufacturers claim that the business has been run on starvation prices owing to ruinous competition. The conference will last several days. Every wire mill in the country is represented."

PRICES OF COPPER.

The demand for copper is steady but by no means larger than close buying for immediate consumption and approximate necessities would warrant. In fact the output continues so large that prices may be expected to range below those recently obtainable. Lake Superior copper is quoted at 15 cents, but orders have been taken for delivery during the next month or two in medium quantities at 14¾ cents, and a shade less also.

MR. A. P. WRIGHT, of Boston, has sustained a very severe loss in the death of his mother in England, to which country he was called a few weeks ago by her illness. He has the sympathy and condolence of a host of friends in this great bereavement.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Put Merit in your goods and Truth in your 'Ads.,'
So shall your purse not go lean."

THE EMPIRE CITY ELECTRIC CO.

Dey street has been startled out of its ordinary dinginess by the bright appearance that is made by the front of the large stores at 15 and 17, occupied by the Empire City Electric Co. The growth and development of this company has been rapid. In 1886 the concern was formed and took a modest store at 779 Broadway. Then finding, as business grew, that a removal down town was necessary, it stepped boldly into Dey street, and planted itself right in the very heart of the electrical supply district, with the big Western Union building in front and the handsome Telephone Building behind. The store was opened at 15 Dey, which soon barely sufficed, as it was found necessary to secure large store room in West street. For some time past, the further development of the business has rendered it desirable to give more space to the correspondence and accounting departments as well as more to the salesrooms; and with this object in view No. 17 Dey has been annexed, and an arched passage broken through the party wall, so that the two buildings are practically one on the street level. The new offices are as elegantly fitted up as those of a bank or insurance office, the walls being tastefully papered, while the partitions are of brass and light wood, and the furniture is rich and substantial. At the rear is a beautiful private office, with fireplace of special design. All the office work is done in these new quarters, while the large basement is devoted to the receiving and shipping departments. The Edison light is used throughout the spacious floors, and handsome chandeliers are now being made for the new offices. The Daft power circuits also run into the building. Besides the work done in Dey street the company also draws heavily on its manufacturing establishments at Adrian, Mich., and New Haven, Conn., for its stock, besides shipping direct from both those points.

As at present constituted, the Empire City Co. has Gen. O. E. Madden as its president; E. T. Gilliland, vice-president; H. G. Madden, assistant general manager; Fredk. Lines, secretary, and W. T. Black, Jr., treasurer. There is also a large clerical, sales and traveling staff, and Gen. Madden gives the business continually the benefit of his presence, advice and skill in organization.

TEST OF "INTERIOR CONDUITS" IN CHICAGO, ILL.

An exhibition test was made Dec. 20th and 22d before the architects of Chicago by the Interior Conduit and Insulation Co., of New York. The tests were conducted by Messrs. W. A. Willard and H. M. Underwood.

The exhibition embraced the following tests, viz.: 1st. Setting fire to a board by means of moisture where wires are run at regulation distance apart without blowing safety fuse in the circuit. This proves the ease with which a building can be fired should moisture get between the two conductors, if they are not placed in a tube or conduit, as the current will jump from one wire to the other.

2nd. Making same test with the wires in close proximity showing immediate action of safety fuse without igniting the wood. This test proves the safety of electric light wires, provided they are run in or inclosed in an insulating tube or conduit as at any one time there is not enough combustible material between the two conductors to set afire. This does not apply to mains conveying thousands of amperes, but to branches or taps only.

3d. Fusing a wire with rubber insulation, one piece running through the tube and the other wrapped around a fine strip; showing that electric fires are possible when conductors are not run in tubes. In this case the highest grade of rubber covered wire was used, the fine strip was fired after the insulation on the wire had been ignited, but the insulation on the wire which was in the tube remained partly intact, and did not fire the tube.

4th. Placing two wires in the tube connecting to a bank of lamps and fusing wire. This proves the high resistance of the tube against fire caused by the heating or overloading of the wires.

5th. Placing one wire in tube and the other wire in cap molding, setting fire to molding without injuring the tube, bank of lamps in circuit. This proves the superiority of the tube or conduit over all other methods of concealing wires.

6th. Short circuiting flexible cord inside the tube without injuring it, showing that short circuits do not destroy or fire the tube.

7th. Short circuiting flexible cord outside of tube, setting fire to the insulation. This test illustrated one very common fault and the danger connected with it among users of incandescent electric lights, viz., the moving of a lamp supported by a flexible cord and hanging over a given point, to another position or point by driving a pin or tack through the cord itself and driving it into the plaster or woodwork. The instant the current was turned on, the cord parted and fired the insulation, showing that all pendants should be protected and run in a tube; in case a short circuit occur the fire is immediately smothered; in this case a pin was employed.

These tests were witnessed by a large number of the leading architects in the city, who expressed themselves more than pleased with the demonstrations and results.

CUTTER'S LAMP SUPPORTING PULLEY.

This ingenious device, which is shown in the accompanying engraving, is about to be put on the market by George Cutter, of 333 The Rookery, Chicago, and will meet the demand for a sleet-proof pulley which will support the lamp safely, even if the rope should get loose. The lamp is hung from a hook whose large knob is engaged by ridges, projecting from the sides of the pulley, which automatically support the lamp when raised, or release it again when about to be lowered. This is accomplished without the addition of any moving parts, in the manner shown.

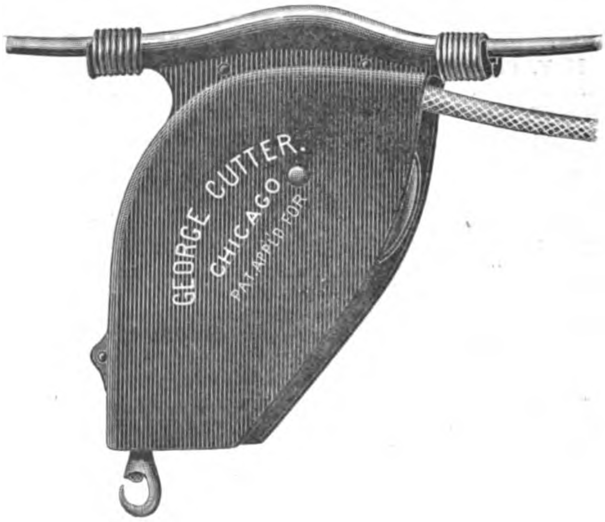

GEORGE CUTTER.
CHICAGO
PAT. APPL'D FOR.

Fig 1.—Cutter's Lamp Supporting Pulley.

On raising the lamp the knob is guided by the raised ridges until it strikes the curved stop; then on slackening the hoisting rope, the knob is pulled down by the weight of the lamp into the recess in the lower corner of the pulley. The lamp is then supported entirely by the pulley, so that the hoisting rope may be loosened, or even cut, without letting the lamp fall. To release the lamp, it is raised until the knob has passed the corner of the upper ridge, when it will be guided out (as shown by the dotted lines in the cut) and the lamp can be lowered.

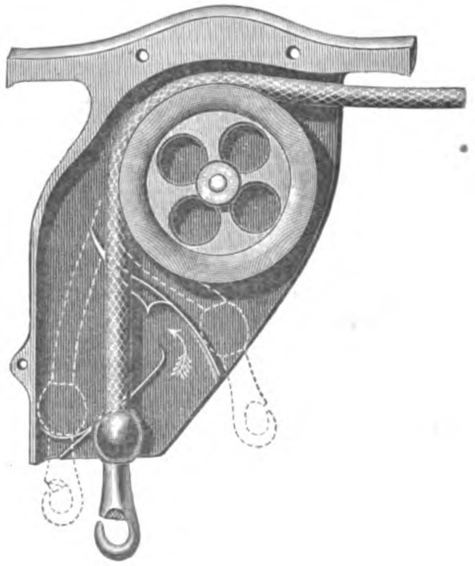


Fig. 2.—Interior of Pulley.

Both the engaging of the hook and the releasing are accomplished in turn by raising the lamp till the knob strikes a solid stop, and then slackening the rope. This leaves no time to be wasted in trying to stop at some exact point, or to disengage a series of interlocking cams, but makes the action as positive as it is simple.

The method of fastening the pulley to the suspension wire is also new and requires no bolts or screws to keep the pulley in its place. As the cuts show, the suspension wire rests in the grooved upper edge of the pulley and is held there by two wires wrapped around the ends of the pulley. The kink put into the suspension wire by this method of fastening effectively keeps the pulley from slipping along the wire, the more so as there is no tendency for this, excepting while the lamp is being raised or lowered.

That Cutter's lamp supporting pulley will adapt itself for use wherever arc lamps are used, is evident from its simple and ingenious construction; other uses in and about central stations will readily suggest themselves to station superintendents.

PAISTE'S PITHY POETRY.

H. T. Paiste, the well-known switch manufacturer, of 1201 Market street, Philadelphia, has issued a very pretty steel plate calendar, which like most of those coming from the decorous old city on the banks of the Schuylkill, has, as its chief ornamentation, the figure of a pleasing young girl. Why the Philadelphian taste runs that way, we do not know, but it is a gentle trait one cannot find fault with. Mr. Paiste is not satisfied with art, however, but has secured the following lines signed "J. R. H."—the familiar initials of James Russell Hawthorne:—

"At this gay season of good cheer,
Paiste wishes you a glad New Year;
Cannot you do for Paiste the same
And buy the goods that bear his name?
He wants your orders, please remember,
From now clear on to next December."

These lines should be pasted on the memory of every lover of true verse and buyer of good switches. At the back of the calendar are a number of "pointers" to hang it up with. The whole production is another evidence of Mr. Paiste's skill in advertising and of his business enterprise, confirming the impression he makes on the intelligent electrical public by carrying an effective card in every one of THE ELECTRICAL ENGINEER'S 52 Special Convention issues. The only reason why we do not care to hang this calendar in our office is that we want to take it home.

A FORETASTE OF THE NEW YEAR'S BUSINESS.

The Central Electric Company, 116 & 118 Franklin street, Chicago, recently received an order of remarkable magnitude from a western house for electrical supplies, the details of which aggregate some $16,000. A very large amount of Okonite and Candee wire is included in the order, which has already been filled in every particular.

U. S. ELECTRIC RAILWAYS CO.

This company, of 10 Wall street, has just issued a very neat and effective folder full of valuable information compiled by its general manager, Mr. L. W. Serrell, M. E., who has a peculiar knack of getting up in such shape just the little points that practical men want to keep in mind. This folder has a table showing the number and quantity of rails, spikes and splices required per mile of street railway track, with rails weighing 8, 12, 16, 20, 25, 30, 35, 40, 50, 56 and 60 lbs. per yard. Another page embraces a variety of figures as to electric railway operation, and of fuel and steam consumption. The whole is most tastefully printed and will slip into any ordinary pocketbook.

J. ELLIOTT SHAW & CO.

The above concern of 632 Arch street, Philadelphia, have just issued a large and handsome catalogue of the electrical goods they make and handle, a new price list of their electric bells, and a dainty little calendar shaped and colored like their well-known Norway iron frame bell. The house makes a great variety of electric bells, the gongs taking a number of special shapes and giving notes of uncommon richness, penetration, or pitch. In a pithy note or two on the subject, they say: "In the selection of electric bells for service, not only their first cost, but their lasting qualities should be taken into account. They should be so constructed that while the battery current is passing through the magnets, the armature carrying the striker for the gong should receive its full power, and when the contact is broken and the current ceases to flow, no trace of magnetism should remain. In the use of cast iron for the frame or case, cheapness only is taken into consideration, for cast iron having a hard surface, becomes magnetized to a certain extent after being in use a short time, thereby causing the movement to become sluggish, the bells become weak from no apparent cause, and additional battery does not remedy the defect."

CROCKER-WHEELER MOTOR CO.

The business of this company since its removal to Washington and West Fourteenth streets has seen a most rapid extension, and the C-W motor is now one of the best known in the country. The new shops are already filled up with the machinery necessary to keep the output in pace with the orders, and 1891 will see a further extension of their facilities. The company have lately been much gratified at the reception accorded their motor in England, from which country the orders are both numerous and large. Active preparations are now being made for the spring trade, which promises to be far in excess of that of last year.

CHRISTMAS TREE DECORATIONS.

A very effective display, according to the Binghamton papers, was made by Mr. F. J. Root, the local electrical supply dealer and contractor, at the First Presbyterian Church, where he lit up the big Christmas tree. He used thirty-one 16 c. p. Westinghouse lamps of assorted colors, connected in two circuits, so as to vary the colors at intervals, making a most pretty and effective result, upon which he received many compliments. Mr. Root handles all classes of supplies, from a door-bell to a dynamo, and also represents the Edison phonograph. He is building up a large trade.

HEYDRICKS & DUMARS.

The latest addition to the electrical business is the firm of Heydricks & Dumars, whose office is at the corner of Eleventh and State streets, Erie, Pa. The members of the firm are James D. Heydrick and H. T. Dumars, both of whom have been in the employ of the Erie County Light Company, and Mr. Dumars has been with the Keystone Electrical Company for some time. The firm are prepared to wire houses for electric lighting and put in all sorts of electrical apparatus. Both members are active young men bent on making a good record in electrical work.

MERCHANT & CO.

One of the very latest business brochures of the season is decidedly that issued by Merchant & Co., of Philadelphia. It is neither more nor less than a new "Brownie" book, not by Palmer Cox, perhaps, but certainly by a talented artist who can work in the spirit of the master. The sketches, of which there are a couple of dozen, illustrate the brownies handling electrical supplies, roofing, brass and copper tubing, sheet metal, ventilators, aluminum, nickel, tin, etc., cornice sheet metal, drawn and rolled German silver, etc., brazier's sheet copper, and a great variety of other things that the firm has long handled. The electrical sketches are particularly amusing.

CLEVERLY'S CHOICE CALENDARS.

We received a letter last week from Mr. H. A. Cleverly, of the Cleverly Electrical Works, Philadelphia, complaining mildly that he had sent two calendars for the adornment of our office and that we had not acknowledged the graceful compliment in good set terms or in any other fashion. On inquiring we found that one of our office boys who has a taste for the beautiful had been prompted by his æsthetic soul to keep those calendars remote from the editorial eye, and in the obscure and crowded recesses of the storage and mailing department. One of them has been rescued and we not only now give it this free and unsolicited advertising but have hung it in the editorial rooms, where he who would have his fancy touched by high art can see it any day between the hours of 9 A. M. and 6 P. M., Sundays excepted. We might also mention the fact that in sedate Quaker style Mr. Cleverly has adorned his letter sheets with the head of a very beautiful woman, the original of which probably sets the Philadelphian eye in a fine frenzy rolling—while we New Yorkers can only be humbly grateful to Mr. Cleverly for his generosity in placing her picture on his fine stationery so that we may admire at a safe distance.

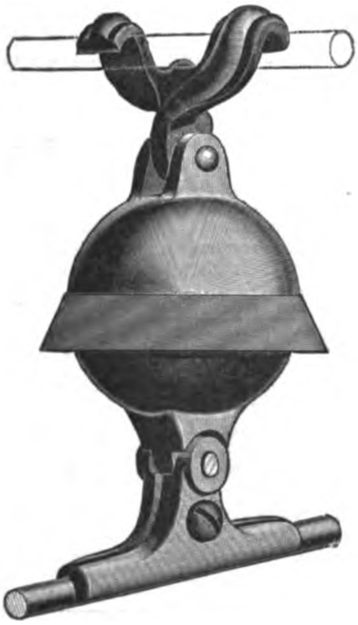
THE McCREARY ELECTRICAL SPECIALTY CO.

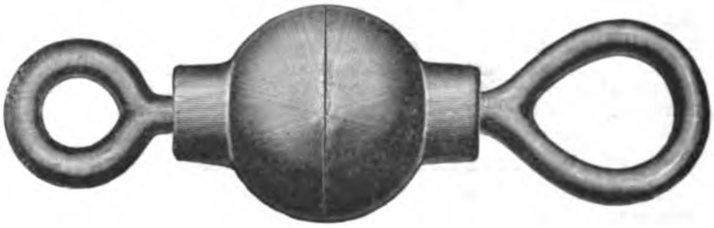
A new catalogue and illustrated descriptive price list has just been issued by the above company of 18 and 20 Cortlandt street. It includes all their well known and meritorious specialties and novelties, including the "Lancaster" switch and McCreary's flexible brass chain, the latter making a highly ornamental covering for flexible cord on all drop or pendant lights. It gives a most artistic finish to a fixture, and serves a doubly useful purpose, for if the cord be made a little longer than the chain, all the strain and weight may be placed on the chain, thus relieving the cord and enhancing its safety.

SOME NEW STYLES OF OVERHEAD INSULATORS.

THE illustrations, Figs. 1, 2 and 3, show a new range of insulators for overhead work, as manufactured by The Electric Construction and Repair Co., 205 and 207 Canal street, Chicago.

They are claimed to be exceedingly light and ornamental, and the main feature of utility is that all soldering is done away with. In the insulator for straight line work the insulation is obtained by a rubber piece half an inch thick, which is also made in such shape as to shed moisture, the form of the top or span wire clamp ensuring a perfect hold, and the bottom or trolley wire clamp giving a perfect hold on the trolley wire, yet at the same time not completely covering it. It is claimed that this insulator can be attached in one-tenth the time of those forms where soldering is required. The same recommendations apply to the curve insulator as are made on that for straight line work.





FIGS. 1 AND 2.—OVERHEAD TROLLEY LINE AND STRAIN INSULATORS.

The strain insulator is undoubtedly an excellent device, its strength being very great, and as will be seen, its shape is very neat and attractive. In all these forms the insulation is entirely concealed in the metal globes. The advantage of this feature can be readily appreciated. The cuts show the construction, which is as follows:—

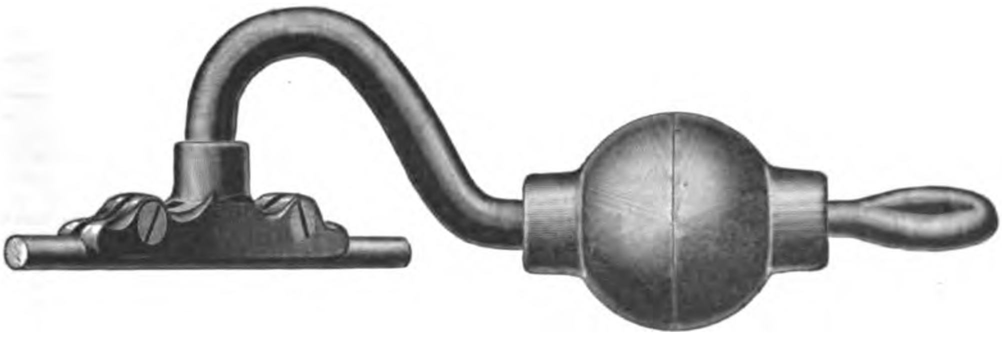


FIG. 3.—PULL-OFF INSULATOR.

No. 1 is made in four parts, top and bottom clamps and the two halves of the globe, between which is placed a rubber piece as illustrated.

No. 2 is made with the insulation, the eyebolt and the hook, on the inside of the globe.

No. 3 is made with the insulation the same as No. 2. In both No. 2 and No. 3 the iron used is made amply strong enough to meet all and more than their requirements.

The company have filed an application for a patent. The cuts shown are exactly half the actual size of the devices.

A NEW INCANDESCENT LAMP.

It is stated that the Great Western Electric Supply Co. are about to place upon the market a new incandescent lamp, which, it is claimed, possesses merits superior to all others.

THE CHICAGO ARC LIGHT CO.

The affairs of the company are said to be in splendid condition. The officers are: President, B. E. Sunny; vice-president, C. N. Fay; secretary and treasurer, C. H. Wilmerding. The directory is as follows: B. E. Sunny, C. N. Fay, Columbus R. Cummings, S. A. Kent, O. S. A. Sprague, L. H. Pierce and V. Shaw Kennedy. The same persons who were originally interested in the enterprise have continued with it, and it is said that some of them have considerably increased their holdings recently. Of the capitalization of $2,000,000 there is $1,230,000 of stock outstanding and no bonded indebtedness. It owns nineteen-twentieths of the stock of the Chicago Sectional Electric Underground Company, which controls the valuable franchise for the system of underground conduits under which the company operates, and has guaranteed 5 per cent. interest on the $260,000 worth of bonds issued by the company. The gross earnings of the company are about $26,000 a month; net earnings about $13,000. The operations of the company for the year ending April 30, 1890, yielded a gross return of $291,339.33, and the expenses were $186,596.90, leaving a net profit of $104,742.43. The business of this year is considerably in excess of last, and it is stated by persons who are familiar with the affairs of the company, that, judging from the present receipts, the net profits for the fiscal year ending April 30, 1891, will be $156,000. The company has so far paid quarterly dividends of 1½ per cent., the first having been declared January 15, of this year. Beginning with July, dividends are declared the first quarter.

THE AMERICAN ELECTRICAL WORKS.

Accompanied by a bright new one cent piece, done up in a small envelope in the left hand corner, the American Electrical Works issued the following Christmas card to its friends: "At this season of gift making and general good feeling we want to contribute our share to the festivities, and beg your acceptance of this slight token. Not knowing your personal tastes, and fearing duplicates of gifts, we send coin (legal tender) and urge you to spend it freely for whatever your inclination dictates, whether for art, insulated wires or tutti frutti. Gratify your wants fully; let Pleasure have her sway; but avoid foolish extravagance remembering that 'A penny saved is a penny got.'"

THOMSON-HOUSTON SALES IN THE WEST.

The Western Isolated Department of the Thomson-Houston Electric Co. has received the following contracts: National Distilling Co., Milwaukee, Wis., 100-light incandescent plant; St. Louis R. R. Co., St. Louis, Mo., plant for the cable power house, located at Broadway and Lami streets, of 200 incandescent lights capacity. They reported recently a sale to the same company for a 400-light plant which is now being installed at another power station located at Broadway and Salisbury streets.

HUNT ENGINEERING CO.

The above pushing and energetic young company moved on January 6 into their new offices at 238 Washington street, Brooklyn. They have rented the entire building, and before they get through will have ensconced themselves very comfortably and conveniently. The outlook for 1891, under the new auspices, is bright.

ANGLE AND BRANCH BLOCKS FOR SEELY'S FLEXIBLE MOLDINGS.

OUR readers are already acquainted with the very useful invention of Mr. John A. Seely, of this city, who has lightened the labors of the house wirer and at the same time increased the safety of wiring work by what is known as Seely's flexible molding. This molding is made by imbedding thoroughly insulated wire in a flexible composition, which not only adds to the value of the original insulation of the wire but allows of the same being run in the most inconspicuous manner and to take the curve or outline of every part of the room with ease and without injuring the insulation. The accompanying engravings, Figs. 1, 2 and 3, show in plan and section different sizes of this molding. Where it becomes necessary, however, to turn sharp angles, an angle block is introduced, which is shown in Figs. 4, 5 and 6. This block consists of two parts and is made of Mr. Seely's well-known composition, which is both insulating and fireproof, being made up largely of asbestos. The manner in which the flexible molding is applied is very clearly shown, one side being slightly cut down on each branch and connection made with the screws provided for that purpose. When the joints are completed the cover is screwed down.

When it is desired to take a branch from any circuit the branch block shown in Figs. 7 and 8 is employed. Fig. 7 shows the branch with the cover off and the cover below it. Here a somewhat similar proceeding as in the former case is applied, the manner of which is very clearly shown. Fig. 8 shows the branch block with the cover on. The application of the angle and branch block thus gives a complete system for the application of flexible wiring which has already met with much favor. These blocks are made by the Complete Electric Construction Company, of this city, manufacturers of the flexible wire molding.

BIG SHIPMENTS OF BELTING.

Passing by the store of Chas. A. Schieren & Co., Cliff street, one day last week, the attention of the writer was attracted by the shipments being made of belting. One of these belts was 150 feet long and 72 inches wide, and two were 48-inch double belts about 100 feet long; all being a second order from the Louisiana Electric Light Co., of New Orleans. There were also two 36-inch triple belts of the "Electric Perforated" type for a large iron works; a 54-inch three-ply for a large electric railway plant and a 41-inch three-ply for a big electric light plant. These belts made quite a display, and represented about $10,000—but the house was taking it quite as a matter of course.

PETTINGELL, ANDREWS CO.

There is nothing small about Pettingell, Andrews Co., of Boston, nor is there about the calendar they have just issued for 1891. It is big enough in fact, for two years, and owing to its size is intended chiefly for use outside the Bay State. We intend enlarging our offices, for the fifth time in nine months, so as to find room for this choice specimen of the printer's art, and have made up our minds that when we have leisure enough to sit down and figure out the percentage of growth of our circulation over what it was week before last, down to the tenth decimal, we shall borrow the type used in this broad sheet as the only kind big enough to do our increase justice. The calendars that he who runs may read we have long had with us—153 more of them arrived yesterday—but the calendar that can be read as you shoot past it in an electric express at the rate of two-and-a-half miles a minute is still the leading novelty of its class, and the electrical public has to thank the enterprise of Pettingell, Andrews Co. for it. May their sunshine and their calendars never grow less!

THE BREWER ELECTRIC RAILWAY CONDUIT.

In our issue of Nov. 26, 1890, we described the ingenious electric railway conduit designed by Mr. W. J. Brewer, of No. 115 Broadway, N. Y., in which the prominent features were the complete insulation of the working conductor and the simple method of construction of the conduit. Mr. Brewer reports that his system is attracting favorable notice from many quarters and that three street railway companies are now making a thorough examination with the view of adopting it on their roads. We may add that we have seen estimates of the cost of construction of the Brewer conduit which show that it exceeds but very little the cost of what is now recognized as the proper method of overhead line construction, so that the underground system is to-day well within the reach of street railway companies.

MR. C. D. SHAIN, general manager of the Eastern department of the Edison General Electric Co., was presented with a handsome diamond pin on Christmas eve by the employés of his department as a Christmas present and a token of their regard and appreciation of the kindness and courtesy he has always shown them.

B. & S. ELECTRIC EQUIPMENT CO.

This company has recently been organized, with offices at 115 Broadway, by Mr. E. T. Birdsall, M. E., and Lemuel Wm. Serrell, M. E., both gentlemen of large experience in the various branches of electrical engineering, and well qualified to see in advance the requirements of the electric railway and station manager. Mr. Serrell is well known as the designer of the present type of "C. & C. motors," besides being a prolific inventor in other fields. Mr. Birdsall was for several years with the Edison and other electric lighting and railway companies, and now enjoys an extensive business as a consulting engineer for electric railways. The company is putting on the market a line of electric railway pole-line apparatus which has been pronounced by several electrical engineers to be the best in design and efficiency brought out up to the present time. In addition, the company are selling agents for the Walworth iron poles, the American Circular Loom Co's "Canvas Jacket" wires and cables, the Russell arc lamp, etc. It will be the aim of this company to supply electric railway and lighting stations with appliances of a higher standard of excellence than it has been possible heretofore to obtain, and to design and manufacture improved high grade electrical appliances and fittings.

W. R. FLEMING & CO.

Messrs. W. R. Fleming & Co., 174 Fulton street, N. Y. City, agents for the Harrisburg "Ide" and "Ideal" engines, have closed contract during the past week for complete steam plant for North Plainfield, N. J., 50 h. p. The "Ideal" self-oiling engine to be used, and horizontal tubular boiler with Weitmeyer setting (patent furnace).

They have also taken orders from the well-known firm of Ketcham & McDougal, of York and Washington streets, Brooklyn, for 50 h. p. "Ide" engine to run an electric light plant which is to be installed by this concern.

"FEWER CARES" AND "INCREASED EARNINGS."

These are the twin mottoes that adorn the Season Greetings card issued by Alexander, Barney & Chapin, and they will go to the heart of every station superintendent who has been called up to locate a dead ground five miles out from home, in the rain, at 12:30 A. M., or has had his wires cut down and his rates for city lights cut up. The firm not only offer these mottoes to their friends but propose to adopt them for themselves.

THE PERRET MOTORS.

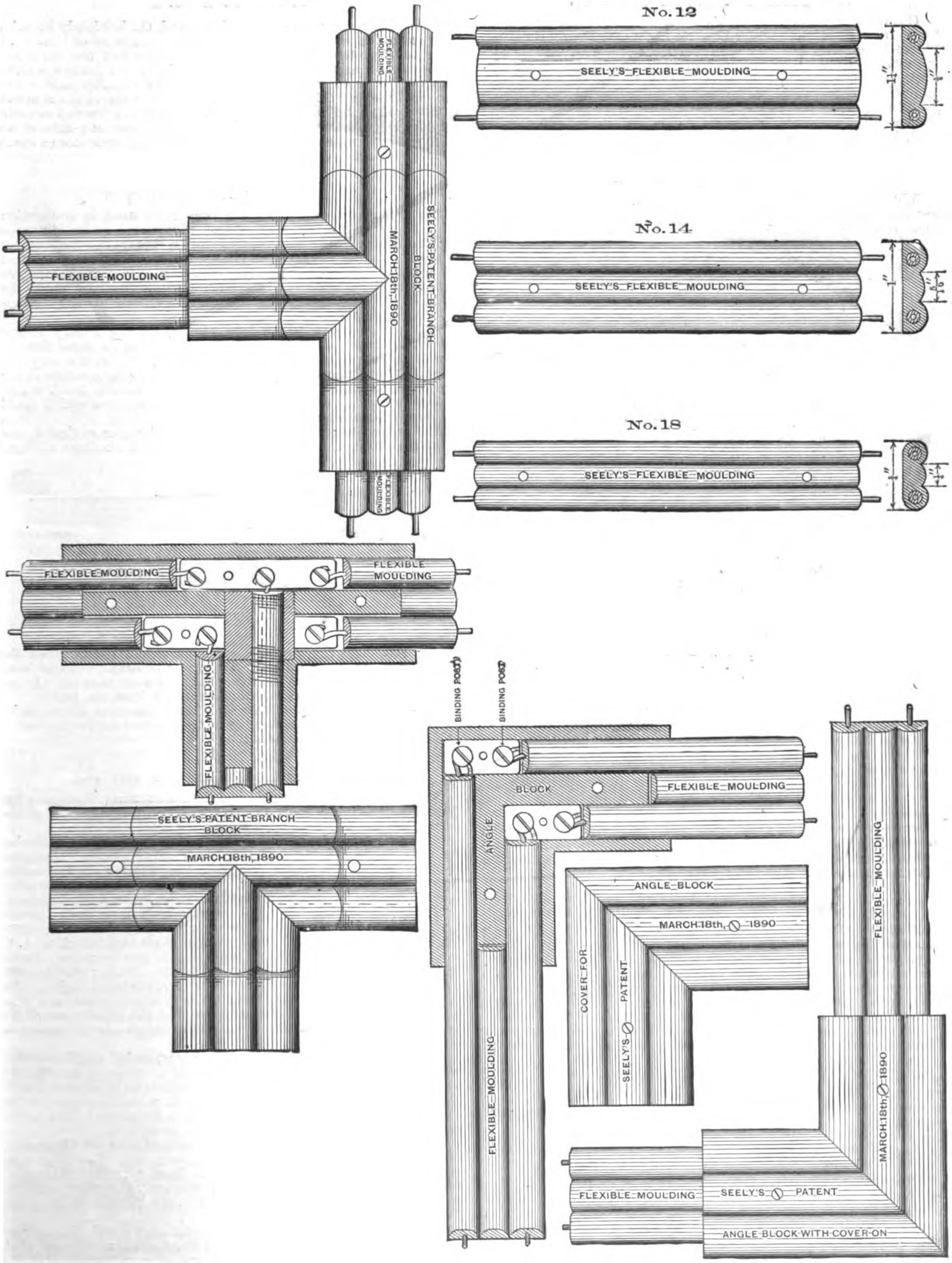
The Elektron Mfg. Co., of 79–81 Washington street, Brooklyn, have been sending out another batch of their excellent literature relative to the Perret motor. From their "List F." we extract the following interesting details as to sizes, speeds, etc.

Horse-power.	Voltage.	Approx. speed.	Diam. pulley.	Belt.	Weight. lbs.
1/12	2 to 10	* Has 3 speed switch.	1¼ in.	Round 1-8	13
1/12	4 to 10		1¼ in.	Round 1-8	13
1/8	12 to 110	2500	1¼ in.	Round 3-16	16
1/8	12 to 110	2500	......	....	20
[illegible]	20 to 110	2500	1⅜ in.	Round 3-16	25
¼	25 to 120	2000	2 in.	1 inch	50
½	25 to 230	2000	2¼ in.	1½ inches	70
¾	25 to 230	2000	2⅜ in.	2 inches	90
1	60 to 230	2000	4 in.	2 inches	155
2	60 to 230	2000	4 in.	2½ inches	200
4	100 to 500	600	8 in.	4 inches	500
7	100 to 500	600	8 in.	5 inches	700
10	100 to 500	600	10 in.	6 inches	900
15	100 to 500	600	10 in.	8 inches	1100
20	100 to 500	600	10 in.	9 inches	1250

It may be mentioned that in addition to their motors, the Elektron Co. handle rheostats, fans, Eaton ammeters, voltmeters and volt-ammeters; Deprez-Carpentier ammeters and voltmeters, and Kohlrausch's small spring ammeters.

STANDARD UNDERGROUND CABLE FOR FRANCE.

A special dispatch from Pittsburgh, of Dec. 27, says:—"The Standard Underground Cable Company of this city has secured a contract from the French Government for the erection of a plant with which to manufacture the underground cables for that republic. A. J. Waring left last night for New York to sail for Paris to begin the work. The French Government has determined to bury all the wires under its control. The plant which the Pittsburgh concern is to build will turn out about $1,500,000 worth of cable wire yearly. The same corporation is negotiating for the erection of similar works in Berlin."



Figs 1, 2, 3, 4, 5 6, 7 and 8.—Angle and Branch Blocks for Seely's Flexible Electric Moldings. (See page 28.)

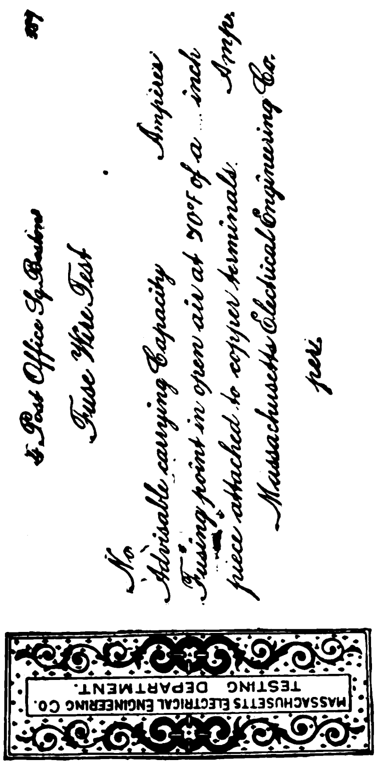
THE HEISLER ELECTRIC LIGHT CO.

On page xxiv. of this week's ELECTRICAL ENGINEER will be found the card of The Heisler Electric Light Co., Drexel Building, Philadelphia, who say they wish to correspond with various parties relating to the distribution of agencies for the Heisler system.

Since this company determined to move and concentrate its manufacturing and sales departments in the East, General Manager Walter F. Smith has been busy night and day effecting the change. The company has greatly enlarged its manufacturing facilities, and will now push its apparatus on the market.

TESTED FUSE WIRE.

WE give herewith an exact reproduction of the certificate of test put on all reels of fuse wire tested by the Massachussetts Electrical Engineering Company, of Boston. The demand for an accurate fuse wire is so great that users of it will no doubt be interested to note the copy of the certificate, which gives the fusing point and safe carrying capacity, and to recognize the same when purchasing of their dealers.



4 Post Office Sq. Boston

Fuse Wire Test

No.

Advisable carrying Capacity Amperes

Fusing point in open air at 70°F of a ... inch piece attached to copper terminals Amps.

Massachusetts Electrical Engineering Co.

per

MASSACHUSETTS ELECTRICAL ENGINEERING CO.
TESTING DEPARTMENT.

CERTIFICATE OF FUSE WIRE TEST.

DAVENPORT FOUNDRY AND MACHINE CO.

A contract has been closed by the Davenport, Ia., Foundry and Machine Co. with the Berlin, Wis., Electric Light Co., for a 100 h. p. Meyer automatic engine, 60 x 16 boiler, heater and pump. They expect to have this plant in operation by January 20. The Meyer engine, which is rapidly finding its way into the electrical field, is the design of Mr. H. H. Meyer, the secretary and treasurer of the company.

CLINTON WIRE CLOTH CO.

The above company, of 137 Lake street, Chicago, with offices at New York and Boston, are manufacturers of wire netting of all kinds and grades, including that for the electrical trade. They make netting for rheostat boxes, dynamo polepieces, etc., and will furnish to any requirement.

UNION SWITCH AND SIGNAL CO.

The Union Switch and Signal Company, of Pittsburgh, has received the contract from the Pennsylvania Railroad Company to signal a new road at Jersey City. The same company has also been awarded the contract for the same kind of work on the elevated railroad extending from the ferry slip out to Shanley's Cut, a distance of three miles. The electro-pneumatic will be used, and there will be three towers and a number of 1,200 feet blocks equipped with electro-pneumatic track circuit block signals.

R. THOMAS & SONS.

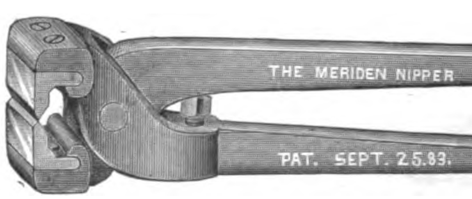
The above concern, of East Liverpool, O., has lately issued a very extensive and complete illustrated catalogue of its hard vitreous porcelain electrical supplies. They sell the porcelain only without screws or fittings. The body and glaze are alike composed of earthy materials. No lead or metallic oxides are used in the glaze. All the goods are fired with natural gas to about 4,000 deg. Fah. The first part of the catalogue is devoted to their general lines, the rest shows a number of special pieces made from models furnished by the originators. The back cover gives a view of the large works.

THE MERIDEN CUTTING NIPPERS.

There is perhaps no tool more frequently used in connection with electrical manufacturing and the wiring of buildings, as well as in connection with central station work, than the cutting nippers, and hence it is of the utmost importance that such a tool should at all times be in the best working order. To insure this Mr. Henry B. Todd, of Meriden, Conn., has designed the "Meriden" cutting nippers, which are shown in the accompanying engraving.

The aim has been to produce nippers having a very strong connection between the head and cutter, and at the same time so simple that the extra cutters can be furnished to fit, at a very low price. One of the principal features of the nippers consists in the simple manner of fastening the cutter to the handle head, which is at the same time one of the strongest connections which could be devised for the purpose.

The screw threads are tapped in the steel cutter so that a new thread is obtained with each new cutter, which obviates all danger of stripping the threads, as sometimes happens when the thread is cut in the iron head. The screw holes through the head are away from the joint of the nipper so that that part is not weakened by having the holes drilled into it from the top.



MERIDEN CUTTING NIPPERS.

It will be observed that there is a large clearance space under the cutters which makes them specially adapted for cutting wires of large diameter, sheet metal, etc.

THE WESTINGHOUSE RECORD FOR 1890.

The Westinghouse Electric and Manufacturing Company has just completed the most successful year in the history of the organization.

According to the report of shipments made up to December 31, 1890, the company shipped 217 alternating current incandescent dynamos of a capacity aggregating 248,150 sixteen candle power lights during last year. This makes a total of 730 alternating current incandescent light machines, with a total capacity of 720,800 sixteen candle power lamps, which have been shipped by the company since its organization in November, 1886. During the first year, i. e., 1886, the shipments amounted to A. C. apparatus aggregating 2,400 sixteen candle power lamps; during 1887 there were 106,200 lights; during 1888, 119,950; during 1889, 228,150, and during last year 248,850 incandescent lights. The figures prove the year just closed as the greatest record the company has ever made, and it also shows that the reputation of the apparatus manufactured by the Westinghouse company is constantly increasing.

During last year the company, however, added another branch to its business, in the manufacture of electric street railway apparatus. The company did not commence to ship motors until the first of July. Since then 211 15 h. p. motors have left the shops for the equipment of forty electric railways. This makes an average shipment of over 35 motors per month.

The company also commenced the manufacture of alternating current arc light apparatus during the last year. The first shipment of these machines was made in January, 1890. Since that time the company has shipped 107 alternating current arc light dynamos aggregating a capacity of 5,680 2,000 candle power lamps.

The Shallenberger alternating current meter and the converters utilized in connection with the Westinghouse system of alternating current electric lighting are now well known all over the globe. There are now over 20,000 Shallenberger meters and more than 30,000 converters in use.

During the month of December the company received orders to increase the capacity of seven central station plants where its alternating current system is already in operation, and, in addition, a number of new contracts were obtained for the installation of incandescent as well as arc light apparatus. Among the latest orders are: An increase of 750 lights for Olean, N. Y.; 3,000 lights for St. Louis, Mo.; 1,500 lights for Keokuk, Ia.; 3,000 lights for Louisville, Ky.; 500 for Wilmerding, Pa.; 750 for Mansfield, Pa.; 750 for Albion, N. Y.; 750 for Berlin Falls, N. H.; 750 lights for Windsor Locks, Conn., and 500 for White Water, Wis.

CENTRAL ELECTRIC CO.

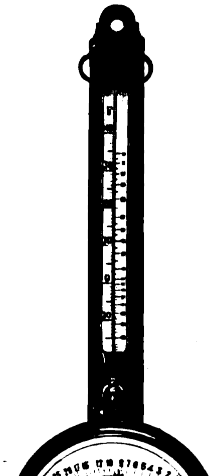
An unexpectedly large demand has arisen for the new Bain glass and break insulators recently illustrated in these columns. The Central Electric Company has just received its first stock order of these articles, and report that every insulator was sold before the shipment arrived. These insulators have a very practical appearance, and construction men speak highly of them.

Orders for Okonite and Improved Candee wires continue to flow to the Central Electric Company, and these standard articles seem to have no dull season, such as is expected in other lines of electrical supplies.

LAMBRECHT'S POLYMETER.

One of the neatest and most compact little instruments which we have come across is the "Polymeter," which combines in itself the means for determining no less than five most important meteorological conditions. It is frequently a matter of much concern to the manufacturer and more particularly to the central station superintendent to know the exact condition of the weather; and to be able to forecast it places him in a position to apply suitable measures to prevent interruptions in the service. The telegraph and telephone superintendent, likewise, when thus informed, is able to make suitable preparations which may prevent much annoyance and delay.

The instrument, which is illustrated in the accompanying engraving, embodies a thermometer, and below it a hygrometer, by means of which the relative humidity and the dew point or absolute humidity can be read off. In addition to this, the instrument gives the vapor pressure in millimetres of mercury and the weight of vapor in grammes in a cubic metre.



The Polymeter.

With such an instrument at hand the observer can easily make arrangements to meet the existing meteorological conditions as well as those which the instrument foreshadows.

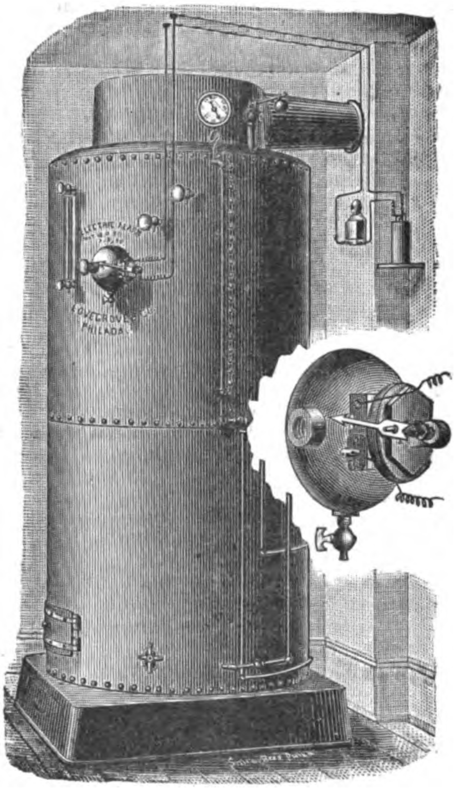
The "Polymeter" is made by Messrs. Gall & Lambke, of No. 21 Union Square, this city.

Mr. A. Langstaff Johnston, civil and consulting engineer, P. O. Box 43, Richmond, Va., is making a specialty of the construction of electric railways, a branch of work to which he has long paid attention. He announces that he is now in the field for any work of this class.

THE LOVEGROVE LOW WATER ALARM.

The accompanying engraving represents a new electric low water alarm for steam boilers, tanks, etc.

The alarm consists of a cylindrical casting which is attached to the boiler or water column by unscrewing the lower gauge cock and screwing in the alarm, after which the gauge cock is screwed in the casting and can be used as usual. The casting contains an improved float which is connected to the atmosphere through the stuffing box by means of the hollow rocker arm, to which the index is attached. This connection prevents the float filling with water and becoming inoperative. A vibrating bell is connected with the alarm, the circuit of which is closed by the float when the water sinks below the proper level. As a dry battery is employed in connection with the alarm, the latter requires practically no attention whatever. The device, which is exceedingly simple, is equally adapted for a high water alarm and is manufactured by Messrs. Lovegrove & Co., 143 N. 3d St., Philadelphia.



Lovegrove's Low Water Alarm.

ELECTRIC LIGHTING AWARDS IN PHILADELPHIA.

Awards have been made for street arc lighting, to eleven companies, at prices for overhead circuits from 32½ cents to 55 cents. Lights on the city underground circuits are 40 cents. The bids show a decrease of $23,000 to $25,000 in the total of the awards as compared with the previous year.

NEW WESTINGHOUSE PLANTS.

The incandescent electric light is rapidly supplanting the gas lamps out West. The Keokuk Electric Light and Power Company, of Keokuk, Ia., after having established a central station electric lighting plant of the Westinghouse alternating current system last year has just made another contract with the Westinghouse Electric and Mfg. Company for the supply of two dynamos; with this addition, the Keokuk plant will have a capacity of 2,250 sixteen c. p. lamps.

The Albion Electric Company, of Albion, N. Y., where an electric plant of five hundred lights has been operated about a year, is now compelled to increase its capacity. The central station is operating the Westinghouse alternating current system and the Westinghouse Co. has received an order for its apparatus of 750 lights capacity, which will immediately be installed at the Albion plant.

The Crosby Electric Co., of 87 and 89 South Fifth avenue, has issued a special circular announcing the fact that it has secured medals of superiority at the recent American Institute Fair for its Crosby dry battery, Hussey bluestone battery, Eclipse battery and Duplex battery.

NEW ENGLAND TRADE NOTES.

The Automatic Time Stamp Co., of 71 Sudbury street, Boston, have just sent out a very attractive catalogue of their new automatic "Employés' Time Register." This register is designed for automatically registering the exact hour and minute at which an employé enters the workshop, and consists of a clock and stamp, with a suitable receptacle for the reception of the ticket to be deposited by the workman. All a workman has to do is to take a ticket from a special delivery box, write his name upon it, put it into a slot in the register, pull a hook and all is done. The clerk, on opening the register, finds a ticket for each man employed, with an exact register of the time he entered the shop. The device is a good one and all employers of labor should procure a descriptive pamphlet as it is applicable for an infinite variety of purposes and the machine will save its price in a very few weeks.

The Samson Battery.—Colonel Burnham, of the Electric Gas Lighting Co., of Boston, in answer to a letter of inquiry as to the continued working of the Samson battery, has received a vast pile of answers, all of the most flattering description. The battery appears to have well borne out the early impressions of these users, and a few of the phrases in the letters may be quoted. "Best battery in the world," "Would not part with them, if I could not procure more," "Have never used or seen a battery that could equal it," "Too much praise could not be given it," "Improves with age," "Recuperation marvellous," "Gives perfect satisfaction, and have not heard the first complaint." A signal service man says he "finds it superior to any battery he has ever tried and considers it has no equal, has used hundreds and none have gone to the hospital." A telephone man says "it will rival anything in the market." Such good testimony should prove valuable, and keep the battery in the front rank of all open circuit cells.

The Pettingell Andrews Co., of Boston, have bought out the supply department of the business of F. M. Kimball & Co., of Boston, consisting of hanger boards, cleats, molding, etc., and repair parts for the various systems. The goods will still continue to be manufactured by Messrs. Kimball, so that exactly the same class of goods will be sold, but the Pettingell Andrews Co. will have the entire sale. The prices will remain as before.

Mr. George Cutter, of Chicago, was in Boston this week looking up his numerous friends, and arranging prospective agencies. Amongst his most recent arrangements, he has secured the agency for the West of the lamps of the Schaefer Electric Manufacturing Co., of Boston. Mr. Cutter's friends in the East wish him every success in his new venture.

The A. W. Harris Oil Co., of Providence, R. I., besides supplying large quantities of oil specially adapted for the lubrication of all steam engines, are having a large run on their electric dynamo oil, which is made specially to meet the requirements of quick running electric machinery, possessing great viscosity and endurance, and limpid and free feeding in automatic cups. Managers of electric light plants would do well to give this oil a trial.

Drake, Paysan & Whittier, Providence, R. I.—Mr. John J. Drake, of this firm, who unfortunately broke his leg about two months ago, is once more on his feet, and able to attend to business. Since September 1st this firm has installed in and around Providence about 2,500 lamps. They are doing first-class work only, and use only porcelain fixtures for cut-outs, switches, rosettes, etc., of the most improved type, all their work being done in such a manner as to be approved by the Board of Underwriters of New England.

WESTERN TRADE NOTES.

The Illinois Electric Material Co., Rookery, Chicago, the well known dealers in electrical supplies and specialties, are preparing a very handsome catalogue of the many goods and devices they deal in. They control some very unique and valuable specialties for electric light, power, and street railway work. The catalogue will be very carefully compiled, and will compare very favorably with any heretofore brought out.

Mr. G. A. Edward Kohler, hitherto the representative of the Eddy Motor Co., has given up his present position, and with the new year associates himself with The Illinois Electric Material Company, and will push their numerous supplies. I wish him the best of success in his new connection, and congratulate both Mr. Kohler and the Illinois Electric Material Company, whose already prosperous business he will, no doubt, widely extend.

Mr. Albert Scheible is now connected with Mr. George Cutter, at 333 Rookery, Chicago, and will assist him in his work in developing the many new and highly ingenious electrical specialties which Mr. Cutter is now busily engaged in placing on the market, and whose office as stated on his letter heads is becoming quite a "gravitation point" for articles electric.

The Central Electric Co., 116–118 Franklin street, are very active in all departments. The new Bain Glass insulators and Break insulators which they handle are meeting with unparalleled success, and the star of Okonite is ever in the ascendant.

Mr. Chas. T. Jaeger has ensconced himself at 200 E. Kinzie street, Chicago, where he will manufacture his new "Vacuum Pump" for exhausting incandescent lamps, which is meeting with such excellent success on account of the remarkably perfect vacuum obtained with it and its great simplicity and economy. Mr. Jaeger also pays special attention to "glass blowing" for all kinds of experimental and scientific apparatus of the most intricate and delicate character.

The Westinghouse Electric Co. have now got settled in their new quarters in Rooms 925–929 Rookery, Chicago, having moved from the ground floor into more spacious offices owing to their rapidly increasing business rendering more space imperatively necessary. The new offices are very handsomely finished and arranged with a view to comfort and facilitating business; and the benefits derived from the change will be apparent to all.

More Valuable Devices.—The Great Western Electric Supply Co., of Chicago, are constantly adding to their always large stock, specialties of known worth. They investigate all new patents and obtain the latest improvements in the electrical field. Their manager, Mr. H. K. Gilman, says that they will shortly introduce several specialties which are sure to have a very extensive sale.

Electric Railway Equipments.—The railway supplies of the Great Western Electric Supply Co., of Chicago, are of the most complete and comprehensive character. Their rawhide and fibre pinions are quite well known and giving first-class satisfaction. They are introducing a wood pinion that is destined to produce most excellent results, judging from the experiments thus far made.

The Great Western Electric Supply Co., Chicago, are doing a phenomenal business, and the demand for their well-known specialties constantly increases. The fame of this company's goods is rapidly spreading, as is attested by their latest order—a heavy railway contract from Germany. Those interested in electric and combination fixtures should not fail to see the magnificent line shown by the company at 190 Fifth avenue. Their stock is the largest in the West, and it is doubtful if the assortment shown can be equalled anywhere. The Great Western Co. are showing also a very fine and complete assortment of electric goods, suitable for birthday gifts. A toy motor and battery, or telegraph set, complete, makes an acceptable and instructive present for a child.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of January 3, 1891, from New York, Boston and Washington; Pittsburgh, January 2.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	77½	Edison Gen. Elec. Co	87
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Centl. & So. Amer	*145	Consol'd Elec. Lt. Co	...
Mexican	*210	Edison Illn'g Co. N. Y	70
Com. Cable Co	103	U. S. Elec. Lt. Co	30
Postal Tel. Cable	39	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	43¼	Ft. Wayne Co	10¼
" Pref'd	*25¼	Am. Bell	*209
" Series C	....	Erie	46
" " D	5¼	New England	50¼
" Int. Co	....	Mexican	.70 cts
Thomson Welding Co	....	Trop. American	..
Thomson Eu. Welding	55	Edison Phon'gph Doll	1¼

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	*135
Ches. & Pot. Telephone	64	Eck.&Sold. Home Elec. Ry.	58
Amer. Graphophone	12¼	Georgetown & Tenallytown	48

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	13¼

* Ex Dividend.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. JANUARY 14, 1891. No. 141.

THE INVENTORS OF THE ELECTRIC MOTOR.—II.

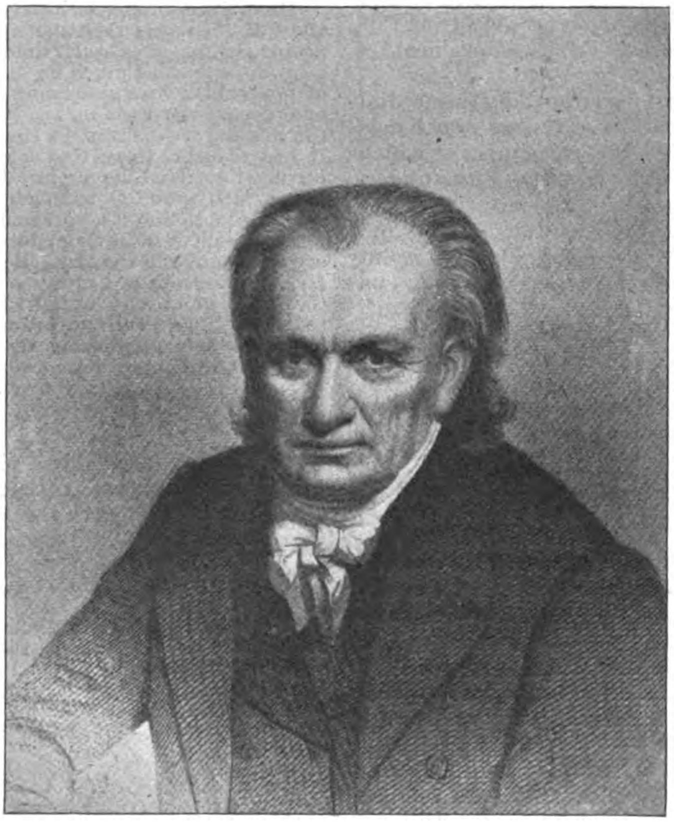
WITH SPECIAL REFERENCE TO THE WORK OF THOMAS DAVENPORT.

BY

Franklin Leonard Pope

ONE stormy day near the end of December, 1834, Davenport and Smalley drove over to Middlebury, taking with them their best machine, which they set up in a room at the village tavern. Davenport then set out to make the acquaintance of the Professor of Natural Philosophy at the college, and invite him to view the phenomenon. This part of the story shall be told in his own words:

> As I had never before seen a college or a professor, I rather dreaded making my acquaintance with those functionaries. I mustered up courage and walked towards the college. As I reached the steps of the building, I saw a fellow with a ragged coat on, an old rusty cap turned over his ears (for it was a cold, stormy day) and a large dirty plank on his shoulder, about entering the college at the same door as myself. I accosted him and inquired if I should be likely to find Prof. Turner about there. He said, "Yes, come in and I will show him to you." I followed him into a lumber room; he threw his plank down, pulled off his leather mittens and said "I am Prof. Turner; perhaps I don't look much like a professor." "As to that, sir," I replied, "I could not say, for you are the only professor I ever saw to my knowledge, but I conclude that your judgment don't lie in your clothes."



Amos Eaton

From a portrait painted by the late Abel B. Moore, circa 1841, and now in the Rensselaer Polytechnic Institute, Troy, N. Y.

Prof. Turner, after having received assurances that whatever the machine might be, it was not claimed to be a "perpetual motion," consented to examine it. The operation of the working model, as exhibited by Smalley, excited his enthusiasm to the highest pitch. He exclaimed :— "Gentlemen, what you have invented is indeed not a perpetual motion; it is nothing less than a *new motive power*, an electro magnetic engine." Prof. Fowler was at once sent for, and upon witnessing the surprising performance of the little machine, became no less enthusiastic than his colleague. In the presence of a dozen or so curious bystanders who had assembled, he made, as Mr. Smalley says, "a regular speech," in which he expressed in emphatic terms the opinion that those present were then witnessing the first exhibition of what would prove to be one of the greatest inventions of the nineteenth century.

Prof. Turner advised Davenport and Smalley to take immediate measures to secure a patent, and with characteristic kindness and generosity undertook to prepare for them a draft specification descriptive of the invention, which he recommended them to place in the hands of a competent attorney at Washington. This interesting document has fortunately been preserved, and the fac-simile of it herewith presented constitutes the best possible evidence of the stage of development which the invention had reached at the beginning of 1835, the date when it was written. This paper, which is in the handwriting of Prof. Turner, is in the following words :—

Davenport and Smalley's Specification of their Invention of an Electro-Magnetic Machine.

Middlebury, Vermont, Jan. 5, 1835.

The following is a description of the electro-magnetic engine invented by Messrs. Davenport & Smalley, of Brandon, Vt., and referred to in the accompanying application of this date. (See drawing below.)

A and B are horseshoe magnets, placed vertically around the axis *ab* to which they are fastened. Of these there may be any number almost; in the model which has been executed there are twelve, although for the sake of simplicity only two are represented in the drawing. It is to be observed that each pair of opposite magnets must have the same poles, as S S, uppermost: but that in case there should be more than one pair, the *adjacent* magnets must have their poles N and S alternately uppermost. C and D are galvanic magnets, or pieces of soft iron having copper wire wound around them, and susceptible of a high degree of magnetism by being connected with either pole of a galvanic arrangement. Q and R are galvanic batteries, consisting each of concentric copper cylinders with zinc between them. 1, 2, 3, 4, 5—16 are cisterns of mercury, of which 1, 6, 11 and 16 are connected with the zinc pole and 2, 5, 12 and 15, with the copper pole by means of wires *z* and *c*. The wires marked *x* connect 3 with 10, 4 with 9, 7 with 14 and 8 with 13. Y T and U V are two levers, turning on pivots at W by the motion of the axis *ab* and carrying with them transverse slips of copper with the extremities bent downwards. When the end Y of the lever Y T is depressed, these slips establish a communication between 9 and 11, 10 and 12, and consequently the wire *m* and the upper branch of C are connected with the copper pole of the battery, and the wire *n* and the lower branch of *c* are connected with the zinc pole. It is evident that, in this case, the upper part of C will be a north pole, and therefore attracted by the pole S of A, while the lower branch of C will be a south pole, and therefore attracted by the pole N of A. In consequence of this attraction the magnet A is brought nearly into contact with C when Y is raised and the end V of the lever V U is depressed; thus establishing a communication between 1 and 3, 2 and 4, or by means of the wires *x*, a communication between 1 and

> 10, 2 and 9, while the connection between 9 and 11, 10 and 12 is interrupted. Hence the poles of the galvanic magnet C will be reversed, the upper one will be south and the lower north; they will therefore be repelled by the corresponding poles of A. In this manner a rotary motion of the magnets A and B on the axis *ab* is kept up so long as the galvanic action continues in the battery. And in the same manner the influence of the battery on the galvanic magnet D or any others may be illustrated. With twelve magnets on the axis and two at the sides, the axis turns round about sixty times in a minute and consequently the poles of the galvanic magnet are reversed 360 times.
>
> To the axis *ab*, it is evident, that any machinery may be attached for the purposes of manufacture, propelling boats, cars on railroads, etc., etc. In the drawing the machinery is supposed to be applied near *b*. The action of the machine may be continued for any length of time by occasionally renewing the fluid.
>
> And on the other hand, the action may be checked or entirely suspended by raising part or all of the connecting wires *c* and *z* out of the cisterns of mercury.
>
> *Instead of the arrangement of magnets above referred to, it is thought that there would be an advantage in employing none but galvanic magnets either on the axis or at the sides.*

The significance of the closing paragraph will not escape the attention of the reader. It confirms the written description of Davenport and the independent verbal statement of Smalley, that as early as 1834 the conception of the combination of stationary and rotating *electro-magnets*, with a suitable pole-changing device, had been worked out and tried by them. The suggestion of applying electro-magnetic apparatus to the propulsion of railway cars is also worthy of note, inasmuch as it was not until fourteen years later that the steam locomotive made its advent in the state of Vermont. The Mohawk and Hudson railroad had, however, been in operation between Albany and Schenactady for some years, and it was probably from this circumstance that the suggestion in the specification originated.

The experimenters were greatly encouraged by the cordial reception which the invention had received at the hands of the Middlebury professors, and the warm interest which they had manifested in the further prospects of the undertaking. It is of interest to record that Davenport now for the first time obtained access to scientific books, from which he could gain some further knowledge of the agent which he was using. Among other works he was shown Silliman's Chemistry, containing accounts of some of Prof. Henry's experiments in electro-magnetism, from which, curiously enough, he first learned the proper names of the instruments and materials he had been using. Up to that time, having been ignorantly instructed by the people at Crown Point, he had called the battery the "cups" and the electro-magnet the "battery."

The difficulties which were inseparable from the use of the mercurial commutator when the rapidity of motion was great, have already been alluded to. Immediately after their visit to Middlebury, the experimenters constructed another machine, and correctly reasoning that the circuit might perfectly well be closed by a metallic commutator, as had been proven by touching of the wires together by hand, they substituted for the mercury contacts insulated segments upon the shaft, which were rubbed by contact-springs formed of elastic flattened wires, and were gratified to discover that this serious obstacle to the rapid revolution of the machine was now entirely removed. This improvement was made prior to May 1, 1835. It appears to be the earliest instance of the use of the modern commutator; an elastic contact-spring or brush, pressing against metallic segments, fixed upon a revolving shaft.*

Not long after the completion of this improved machine, a difference of opinion arose between Davenport and Smalley in respect to the most desirable policy to be pursued in disposing of interests and rights in the invention, in order to raise the funds to cover expenditures already incurred, and to provide the means which were urgently needed for the prosecution of further experiments, as well as for the procuring of patents. An amicable settlement was ultimately arrived at, in accordance with which Smalley relinquished his entire interest in the invention for a sum agreed upon, and Davenport was left free to seek for other assistance in the prosecution of his cherished designs.

For some months he continued his experiments, having for the time transferred the scene of his labors to Rochester, a small town a few miles east of Brandon, at which place, with the assistance of a mechanic named Richardson, he constructed no less than ten machines of different designs, some of which were capable of making 50 revolutions per minute.

The invention having now been brought to a tolerable state of efficiency, Davenport was naturally very anxious to lose no further time in securing his patent. In those days it was supposed to be absolutely necessary that the inventor should visit Washington in person in order to properly explain his ideas. At that date, 1835, this was a long, tedious and expensive journey. Being almost entirely destitute of means to carry out his design, Davenport appealed to his friend and neighbors, and succeeded, after many entreaties, in inducing six of them to make up a joint purse to supply him with funds for his intended journey to Washington. In July, 1835, he set out for the capital, carrying with him his latest model, and a letter of introduction from his friend Prof. Turner to Prof. Amos Eaton, who was at that time principal of the Rensselaer Polytechnic Institute at Troy, N. Y., as follows:

> MIDDLEBURY COLLEGE, June 4, 1835.
>
> DEAR SIR—I take the liberty of introducing to your acquaintance Mr. Thomas Davenport, the inventor of an electro-magnetic machine of singular interest. Mr. Davenport has labored long and expended much on his invention, but has not the means of prosecuting his experiments farther without the aid of some one possessed of taste for the science, and also of funds requisite for making a *fair* trial of the propelling power of his machine. It has occurred to me that could Mr. Van Rensselaer, of Albany, become interested, he might take pleasure in furthering an enterprise which promises so much; and in patronizing an American artist, who, it may be, will one day compete with Watt and Fulton in the glory of having added another prime mover of machinery to science and the arts. Being personally unacquainted with Mr. Van Rensselaer, I presume you will be so good as to do me the favor of introducing Mr. Davenport (by letter or otherwise) to that distinguished and estimable man. This or any other attention you can conveniently render, will be considered as conferring additional obligations on one who has the honor of being,
>
> Sir, your friend and fellow laborer,
>
> E. TURNER.
>
> Prof. AMOS EATON.

The Honorable William Slade, afterwards Governor of Vermont, who was at that time a member of Congress from the district, gave Davenport a note of introduction to the Commissoner of Patents, Hon. H. W. Ellsworth, from which the following extract is of interest as being indicative of his estimate of the man:

> The bearer hereof, Mr. Thomas Davenport, goes to Washington for the purpose of obtaining a patent for the production of motion applicable to machinery by galvanism. His diffidence has induced him to ask a letter to you, which I give with great pleasure. His personal worth is equal to his genius, of which he has given no equivocal evidence in the very ingenious machine for which he asks a patent.

Upon his arrival at the Rensselaer Institute, in Troy, Davenport was most courteously received by Prof. Eaton, who endorsed upon the note of introduction from Prof. Turner, a few lines recommending him to the consideration of General Stephen Van Rensselaer, the eminent founder and patron of the Institute, in which he said:

> I have told Mr. Davenport that no one could consistently aid him without Prof. Henry's approval. I have advised him to exhibit his machine to Prof. Henry, after you have seen it. This he will do. Professor Henry has suggested the practicability of applying this great power to machinery, but I did not from him understand that any plan had been fixed on. Mr. Davenport's plan is a simple and efficient one. . . . . It appears to me that Professor Henry would be greatly delighted

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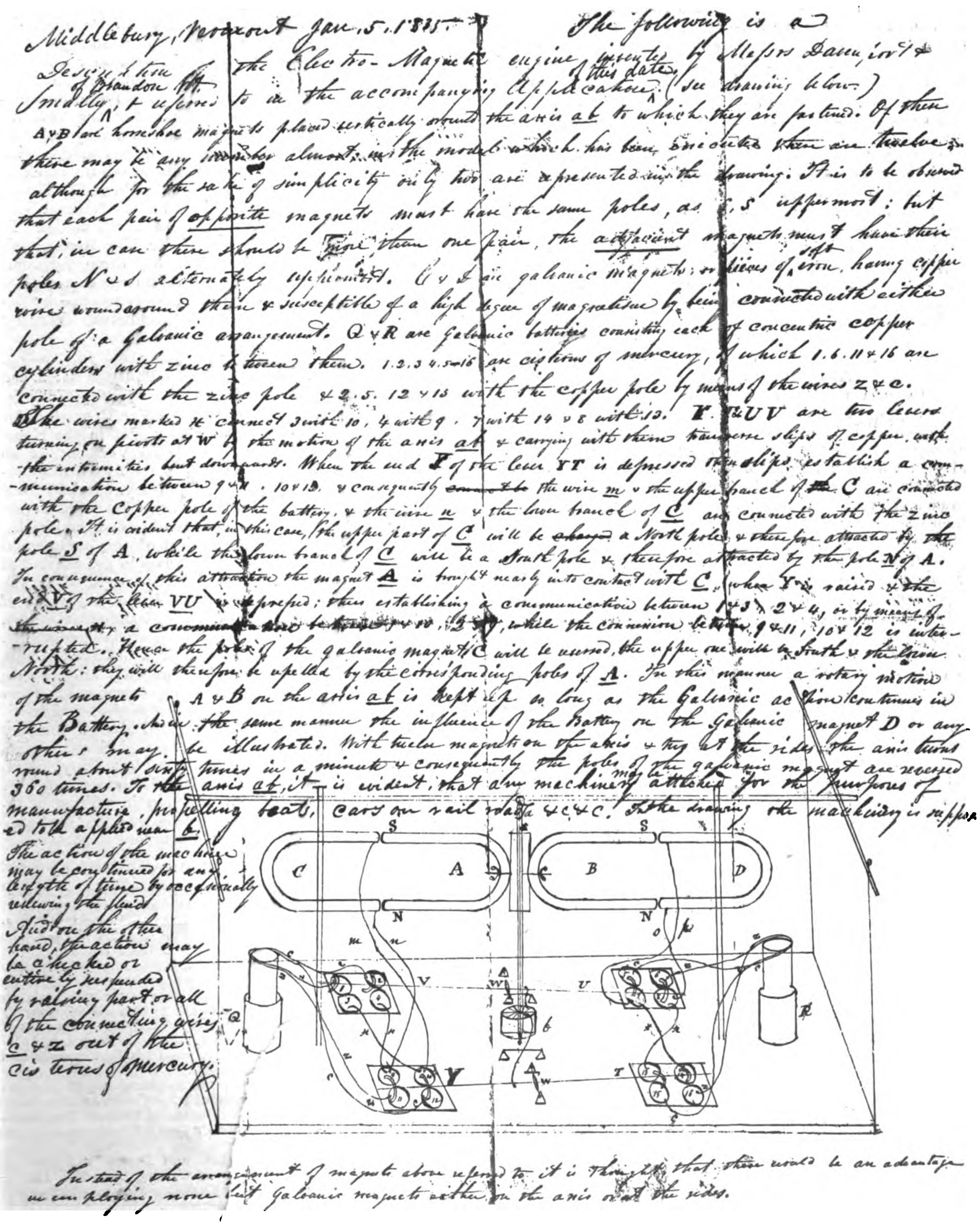
* By an error in copying, the foregoing sentence was attached to the description of Edmondson's apparatus, in p. 3 of the last number of THE ELECTRICAL ENGINEER, to which it obviously has no application.



Middlebury, Vermont Jan. 5. 1835. The following is a Description of the Electro-Magnetic engine invented by Messrs Davenport & Smalley, of Brandon Vt. & referred to in the accompanying Application of this date. (see drawing below.)

A & B are horseshoe magnets placed vertically around the axis ab to which they are fastened. Of these there may be any number almost. in the model which has been executed there are twelve, although for the sake of simplicity only two are represented in the drawing. It is to be observed that each pair of opposite magnets must have the same poles, as S, S uppermost: but that, in case there should be more than one pair, the adjacent magnets must have their poles N & S alternately uppermost. C & D are galvanic magnets: or pieces of soft iron, having copper wire wound around them & susceptible of a high degree of magnetism by being connected with either pole of a Galvanic arrangement. Q & R are Galvanic batteries consisting each of concentric copper cylinders with zinc between them. 1.2.3 4.5–16 are cisterns of mercury, of which 1.6.11 & 16 are connected with the zinc pole & 2.5. 12 & 15 with the copper pole by means of the wires z & c. The wires marked x connect 3 with 10, 4 with 9, 7 with 14 & 8 with 13. YT & UV are two levers turning on pivots at W by the motion of the axis ab & carrying with them transverse slips of copper with the extremities bent downwards. When the end Y of the lever YT is depressed the slips establish a communication between 9 & 11. 10 & 12. & consequently ~~connect to~~ the wire m & the upper branch of ~~the~~ C are connected with the copper pole of the battery, & the wire n & the lower branch of C are connected with the zinc pole. It is evident that, in this case, the upper part of C will be ~~always~~ a North pole & therefore attracted by the pole S of A, while the lower branch of C will be a South pole & therefore attracted by the pole N of A. In consequence of this attraction the magnet A is brought nearly into contact with C, when Y is raised & the end V of the lever VU is depressed; thus establishing a communication between 1 & 3, 2 & 4, or by means of ~~the wires x~~ a communication between 1 & 10, 2 & 9, while the connexion between 9 & 11, 10 & 12 is interrupted. Hence the poles of the galvanic magnet C will be reversed, the upper one will be South & the lower North: they will therefore be repelled by the corresponding poles of A. In this manner a rotary motion of the magnets A & B on the axis ab is kept up so long as the Galvanic action continues in the Battery. And in the same manner the influence of the Battery on the Galvanic magnet D or any others may be illustrated. With twelve magnets on the axis & two at the sides the axis turns round about sixty times in a minute & consequently the poles of the galvanic magnet are reversed 360 times. To the axis ab, it is evident, that any machinery may be attached for the purposes of manufacture, propelling boats, cars on rail roads &c &c. In the drawing the machinery is supposed to be applied near b.

The action of the machine may be continued for any length of time by occasionally renewing the fluids

And on the other hand, the action may be checked or entirely suspended by raising part or all of the connecting wires c & z out of the cisterns of mercury.

Instead of the arrangement of magnets above referred to it is thought that there would be an advantage in employing none but Galvanic magnets either on the axis or at the sides.

Fac Simile of Original Draft of Davenport's Patent Specification of 1835, For His Electric Motor.

with such a satisfactory exemplification of a principle which has extended his name to the ends of the earth.

Acting upon this suggestion of Professor Eaton, General Van Rensselaer gave Davenport a line of introduction to Professor Henry, which he delivered to him in person a few days afterwards at Princeton. Professor Henry was much interested in Davenport's machine, and after witnessing its operation asked how large a power he intended to build, to which Davenport replied "a full one-horse power;" whereupon Professor Henry, with his usual caution, suggested that it would be better if he were to continue his experiments for a time on a smaller scale. He said to him that if it were given out that he was building a one-horse power magnetic machine, and should he fail in his first attempt, which would not improbably be the case, not only would his credit as an inventor suffer, but the electro-magnetic engine would be hastily and unjustly stigmatized as a "humbug," a result which could not be but prejudicial to the advancement of science and the arts. Professor Henry, with the courtesy which he invariably exhibited towards deserving inventors, gave Davenport a certificate, in which he spoke highly of the novelty and originality of his invention. At the same time he did not hesitate to express to him the conviction, which he is known to have entertained even at that early day, that the application of galvanic electricity was at best an indirect way of utilizing the energy derived from the combustion of coal, and therefore could not economically compete with that agent as a means of propelling machinery. He nevertheless believed that it might be found useful in many cases in which the actual expense of power was a consideration not to be weighed against other more desirable objects to be attained. In his views in relation to this subject Henry was far in advance of most of his contemporaries, for the grand conception of the conservation of energy had at that day dawned only upon the minds of a few of the most profound thinkers of the period.

Before leaving Princeton, Henry exhibited to Davenport, much to the surprise of the latter, his oscillating electro-magnetic engine, made in 1831, of which an illustration has been given. This was to him the first intimation that any one prior to himself had even conceived the possibility of producing motive power by electro-magnetism.

While at Princeton, Davenport made the acquaintance of Professor Henry's life-long and intimate friend, Alexander Dallas Bache, then professor of natural philosophy in the University of Pennsylvania at Philadelphia, and afterwards for many years superintendent of the U. S. Coast Survey. At the cordial invitation of Professor Bache, Davenport accompanied him to Philadelphia, where about the middle of July he exhibited his machine in operation in the library of the Franklin Institute. While in this place it was examined with interest by a large number of scientific men. Prior to his departure for Washington, Professor Bache gave Davenport a letter, the conservative tone of which indicates that he had been led by his association with Henry to entertain similar advanced views in respect to the equivalence of the natural forces. This letter is as follows:—

> At the request of Mr. Davenport, I have examined a model of a machine applying the electro-magnetic action as a moving power. At first it appeared to me that an experiment might be made upon this model, from which the useful effects of a machine properly constructed might be inferred. But I am satisfied on examination, that such a result could be had only from a much more complete model than this, or from a working machine of full size. It would be highly interesting in a scientific point of view, and possibly in a practical light, if such an experiment could be made. The power is no doubt adequate to produce any effect which can be required in the arts, but the question of cost can hardly be fairly answered without experimental data.
>
> A. D. Bache,
> Prof. Nat. Philosophy,
> Pennsylvania University,
> Philadelphia.
>
> July 15, 1835.

Upon reaching Washington a few days later, Davenport discovered to his dismay that owing to the unforseen delays and expenses to which he had been subjected by his exhibitions in Troy, Albany, Princeton and Philadelphia, the added cost of preparing the drawings and specifications for his application for a patent would so reduce his available funds as to leave him without sufficient means to return to his home in Vermont. He was therefore compelled by sheer necessity to postpone for the time his intention of applying for his patent, and in a very dejected frame of mind set out for home, taking his model with him, Upon reaching Troy he proposed to sell his machine to the Rensselaer Institute for $30. Professor Eaton, favoring the proposition, gave him a line to General Van Rensselaer, recommending the purchase of the model. In attempting to enter the grounds of Mr. Van Rensselaer's mansion Davenport was set upon by three ferocious watch-dogs, who soon reduced his habiliments to a deplorable condition, although he was fortunately rescued by the servants before serious injury had been inflicted. Writing of this incident, he says:—

> **Mr. Van Rensselaer examined my certificates from Professors Henry and Bache, and the line from Professor Eaton, and meanwhile the kitchen-maid tacked together my torn garments.**

After receiving a check from General Van Rensselaer for the stipulated sum, and depositing his model in the Rensselaer Institute, Davenport returned to Vermont, in no very happy frame of mind. He had not only been unsuccessful in the main object of his journey, but had been brought like many others to a realizing sense of the fact that compliments are far more easily obtained than cash.

The model which formed the subject of this commercial transaction was preserved for many years in the cabinet of the Rensselaer Institute, but ultimately perished in the disastrous fire in Troy in 1862, in which the buildings of the Institute shared the fate of a vast number of others, and were totally consumed with all their valuable contents.

Professor Eaton, who was a man of a deservedly high scientific reputation, as well as of a somewhat enthusiastic temperament, had from the beginning conceived a warm feeling of friendship and respect for the modest and unassuming Vermont blacksmith, and exerted himself in every possible way to advance his interests. Scarcely had Davenport, dispirited and despondent, left Troy, when Professor Eaton penned the following flattering notice of his invention, and procured its insertion in a Troy newspaper. So far as can be learned, this was the first published notice of Davenport's electro-magnetic engine.

> [*From the Troy Daily Budget, August* 13, 1835.]
>
> An obscure blacksmith of Brandon, Vermont, 16 miles south of Middlebury College, happened accidentally to become acquainted with Professor Henry's discoveries in Electro-Magnetism. Possessing one of those minds which cannot be confined to the limits of a blacksmith shop—nor any shop less than the canopy of heaven—he applied this power to the astonishment of scientific mechanics. He turns three horizontal wheels around fifty times per second, with this power. The wheels and shaft weigh eleven pounds. He has convinced Professors Henry and Bache that the power is sufficient for strong machinery. A detailed account of it will appear in the next number of *Silliman's Journal*. The Hon. Stephen Van Rensselaer has purchased his first constructed machine (or model) for the Rensselaer Institute in Troy, as piece of school apparatus. No chemical or philosophical apparatus can hereafter be considered perfect without it. Whatever may be its fate in mechanics, it will cause the name of Thomas Davenport (the inventor) to accompany that of Professor Henry to the ends of the earth.
>
> Professor Bache, of Philadelphia, and Professor Turner of Vermont, have given their opinions in writing that Mr. Davenport's application of Professor Henry's discoveries may be made to move heavy machinery for useful purposes. According to their views, another Livingston might make another Fulton of the Brandon blacksmith.

A month later Professor Eaton wrote to Davenport at Brandon, enclosing a copy of the *Troy Budget* containing the article therein referred to. The letter and extract are as follows:—

[*Professor Amos Eaton to Thomas Davenport.*]

TROY, Sept. 9, 1835.

DEAR SIR:—I published a short account of your invention on the 13th day of August. It was copied into all the papers. Last week some mule of a fellow caused the *Daily Advertiser* to publish a statement that your plan "would not work." The New York papers and others copied it. While some gentlemen were trying to raise money to give you a chance for a trial, that rascally article stopped all exertions, and the subscriptions were burned; I felt it my duty to come out boldly for you, for the sake of my own reputation, and of Bache's, Henry's, and Turner's. You will see how I treat the subject in the *Troy Budget* of yesterday. My object in this letter is to tell you that you must be here about the tenth of October, and put your machine in perfect order; also you must exhibit it *yourself* at three o'clock p. m., on Wednesday, 14th of October, before a thousand spectators.

I will deliver a lecture while you are working it, explaining the principles, etc. The judge's seat in the court room is the place to show it. This small damper will, in my opinion, make your fortune. It will give you a chance to exhibit *truth.* I tell you TRUTH, TRUTH is everything! On that day (October 14) your exertion of your skill will make your fortune. Write me *immediately* telling me positively what to depend on. It is advertised in all the papers that your machine will be exhibited at three o'clock p. m., 14th of October next.

Your friend,

AMOS EATON.

[*From the Troy Daily Budget, September* 8, 1835.]

VERMONT ELECTRO-MAGNETIC MACHINE.

To GILES B. KELLOGG, Esq.,

It was through your agency that Thomas Davenport's astonishing application of Professor Henry's discoveries in electro-magnetism was announced to the world, and it is my particular request that you hasten before the public the following communication to the Albany *Daily Advertiser*, without waiting to copy it from that paper:

To the Editors of the Albany Daily Advertiser.

I have just read in the New York *Commercial Advertiser* the following extract from your paper: "We are sorry to inform our contemporaries that, on further examination, the plan of the Brandon blacksmith will not work." Knowing one of the editors of your paper to be a gentleman of true science and liberal feelings, I feel assured that he will contradict the unkind statement upon my assurance that it is totally untrue. Immediately after Professors Bache and Henry had examined this machine in brisk motion, the Hon. Stephen Van Rensselaer purchased it and placed it in my possession and care, but on account of the battery-cups having been injured in Philadelphia, it has not been put in motion since I received it. But I have often seen it in motion, and know it to be all that has been said of it—an astonishing application of electro-magnetism!

I have no interest in the invention; but, as the unaccountable falsehood which originated in your paper is calculated to injure an ingenious mechanic, I request you to publish this article.

On the 14th of October next, the electro-magnetic machine invented by a blacksmith in Brandon, Vt., shall be exhibited gratuitously, in the Court-house in the city of Troy, to all who may please to call, at three o'clock in the afternoon. It shall be in full action and shall be moved solely by electro-magnetism. It shall carry three wheels weighing eleven pounds, and a miniature trip-hammer, as an emblem of the inventor's avocation.

The fourteenth of October being the last day of the examination of students of Rensselaer Institue, many gentlemen of science will probably be present, to all of whom I pledge myself to demonstrate that the "plan of the Brandon blacksmith *does work*," according to the certificates of Professors Bache of Philadelphia, Henry of Princeton, and Turner of Middlebury.

AMOS EATON,
Senior Professor, Rensselaer Institute.

Davenport was at his home in Vermont when this letter reached him. His fortunes were apparently at their very lowest ebb. Day by day, for more than two years, he had labored indefatigably upon his invention, to the utter neglect of his ordinary means of livelihood. The heavy expenditures incurred in his fruitless journey to Washington had brought him to the end, not only of his resources, but of his credit among his townsmen. His father-in-law, a prosperous and well-to-farmer of Brandon; a shrewd and sagacious, though by no means illiberal man—albeit one who is reputed to have appreciated full well the value of a dollar—offered him every inducement he could think of to put aside his visionary schemes, resume his trade, and henceforth support his family in comfort. Other neighbors, who cherished a sincere friendship and respect for Davenport, joined in the appeal. He could not but be strongly impressed with their practical and common-sense view of the situation, and while in a frame of mind to comply with it, replied to Professor Eaton's letter, stating in effect that two years of incessant labor and anxiety had yielded him but scanty reputation and no money; that his credit was utterly exhausted, while his family were almost suffering for the ordinary necessities of life. Professor Eaton immediately replied, under date of September 21, 1835, deprecating in the strongest terms Davenport's resolution, and refusing to listen to his proposal to abandon the undertaking. Among other things he wrote:—

> Make my name Thomas Davenport, and I will give you five thousand dollars for your idea—rather, I mean "the bubble, reputation." . . . . It is a thing which will progress slowly; perhaps it may never yield you anything but reputation. But you have involved *friends*; and it is your duty to support their pledges for you. . . . Remember, if you fail to be here on the fourteenth, destruction is your portion!

This was the critical moment, the turning point, in the career of Davenport. Not only was the mere thought of throwing aside the hopes and aspirations which he had so long cherished almost unendurable to him, but his keen sense of honor instinctively revolted from the slightest imputation of bad faith towards the scientific friends who had cordially given him their countenance and support, or of reluctance to make good to the best of his ability, their pledges and expectations. On the other hand, to persevere was to be confronted with poverty, doubt, discouragement and almost with despair. To a man constituted like Davenport, however, a mental conflict waged on these grounds could have but one termination. Paraphrasing the memorable words of the elder Adams, he well might have exclaimed at this juncture in his affairs: "The die is now cast; I have passed the Rubicon. Sink or swim; live or die; survive or perish with my invention, is my unalterable determination." With renewed determination he cast aside all despondency and devoted every energy to his preparations for the demonstration at Troy. It is not easy for us to-day to appreciate the formidable difficulties with which he was obliged to contend. Brandon was at that date but an obscure country town, remote from all main lines of travel and transportation, the nearest city of any importance being Troy, N. Y., 100 miles distant, with which communication was maintained by stage-coach. He now determined to construct an entirely new machine, of a model adapted to railway locomotive purposes, and at once wrote to Professor Eaton to procure for him some necessary materials. In reply Eaton wrote on September 25, sending with the letter by a chance stage-coach passenger two packages of No. 16 copper wire, one of 3 and the other of 2 lbs.:

VILLAGE SCHOOLHOUSE AT BRANDON, IN WHICH DAVENPORT'S ELECTRIC RAILWAY WAS EXHIBITED. NOW PART OF RESIDENCE OF GEO. PARMENTER.

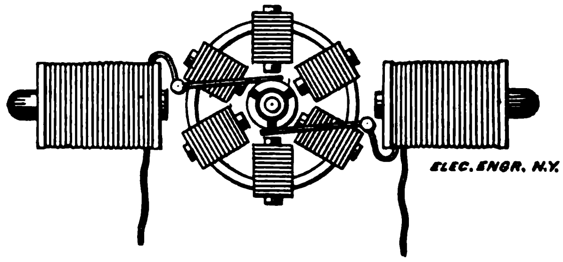
[*From a recent photograph by F. L. Pope.*]

Luckily I find Mr. Jackson (a neighbor of yours) at the stage-office. He promises to deliver you the wire. *I have broken all the hardware stores, and bought all the wire in the city*, and given it to Mr. Jackson.

Then came the difficulty of insulating the wire. Davenport had been led, from Henry's researches, to suppose that silk was the only material which would answer the purpose. But it was not only difficult, but in fact impossible to obtain this material in that remote region, and he was destitute of means wherewith to procure it from the city. But in this dilemma, the unselfish devotion of the faithful wife, who had loyally stood by him through prosperity and adversity, came to his rescue. Her one silk gown, the wedding dress which was her father's gift; almost her sole remaining relic of more prosperous but of perhaps not happier days, was bravely offered as a sacrifice to the cause of science. Cut into narrow strips, the treasured garment was used to insulate the helices of the new machine. Night and day the work went on with such success that punctually on the tenth of October Davenport presented himself at the Rensselaer Institute with the new motor in readiness for exhibition. On the 14th, pursuant to the pledge of Professor Eaton, it was put in operation on the Judge's bench in the court-room in Troy, in the presence of hundreds of interested and enthusiastic spectators.

Among the audience who attended this exhibition was a young artisan whose home was in Cabotville, a village just north of Springfield, Mass., which then enjoyed a high reputation, as indeed it does to-day, for the skill of its mechanics and the excellence of its products. This young man became greatly interested in the new motive power, and proposed to Davenport that he should immediately accompany him to Cabotville, promising to assist him to the best of his ability in bringing the invention into practical use. The proposal was accepted, and the two worked together at that place for some two months, during which time they completed a model of a circular railway 36 inches in diameter, upon which an electro-magnetic locomotive traveled with amazing rapidity. At the end of this time Davenport was informed by his associate that he was disinclined to go any further with the enterprise, but as Davenport himself says, he had little reason to complain of his conduct, inasmuch as he willingly gave him the benefit of two months' labor and his board during the time, to say nothing of some small expenses which had been incurred. It was now the middle of December and our inventor was again left in a state of destitution at a distance of 150 miles from his home. Hardly knowing which way to turn next, he bethought himself of a letter which he had received just before his visit to Troy from a silk manufacturer in Dedham, Mass., who desired to apply electro-magnetic power to the processes employed in his factory.

Among other acquaintanceships which Davenport had formed while in Cabotville, was that of a Mr. Kimball, himself an intelligent mechanic, who had taken much interest in the project of the electric railway. In his perplexity he consulted Kimball and was advised by him to take his machine to Dedham, and in case he failed to conclude a satisfactory arrangement with the silk manufacturer, to try a public exhibition of his circular railway in Boston, by which means he might perhaps raise sufficient funds to aid him in making further experiments. In addition to his good advice, Kimball very generously handed him $50 for his expenses, and not content with that, told him if his plans all failed to let him know, and he would cheerfully render him further assistance. "Such kindness," writes Davenport, "from a stranger whom I had never seen half-a-dozen times in my life, seemed to be an omen of future prosperity." He proceeded to Dedham, and although "received most politely" by the silk manufacturer, that person did not seem inclined to take any chances in testing the capacity of electro-magnetism for winding silk, nor did he offer to reimbuse Davenport for the expenses he had incurred in bringing his machine a long distance for exhibition. As a last resort the persevering inventor proceeded to Boston, hoping, as he says, "that the thinking portion of that intelligent city would be highly gratified with an exhibition of the wonderful effects of the silent, unseen and irresistible power of electro-magnetism." He accordingly exhibited his locomotive two weeks at the Marlborough hotel, and realized the princely sum of $12, just sufficient to meet the charges of his landlord for the use of the room. Davenport states that notices of this exhibition were published in some of the Boston newspapers of the day, but a diligent search through the columns of such journals as have been preserved has failed to reveal them. The exhibition, however, is well remembered by Thomas Hall, the veteran manufacturer of electrical instruments in Boston, who, although but a boy at the time, was employed in the shop of Daniel Davis, Jr., in which scientific instruments were made and repaired. According to the recollection of Mr. Hall, the machine consisted of a number of small magnets placed upon the rim of a vertical wheel, and constituting a sort of pole-armature, which revolved between the poles of two larger electro-magnets placed in a horizontal position which formed the field. His impression is that the field magnets were connected with the armatures in series. The current was supplied by a large Wollaston battery, and as the zincs became rapidly coated with oxide, necessitating frequent cleaning, two sets of batteries were provided, one of which was used while the other was being cleaned. The motor and battery were mounted upon a truck which traveled at a considerable speed.[*]



The Davenport Motor Exhibited in Boston, as Remembered by Mr. T. Hall.

At this juncture he received a letter from Kimball, cordially inviting him to stay at his own house for a few weeks and promising to furnish materials for building a larger machine. He accepted the proposal—there was obviously nothing else to be done—until finally, upon his expressing a desire to return to his family in Vermont, the generous Kimball furnished the dejected inventor with a new suit of clothes, and the necessary cash for his journey, and when in parting from him Davenport expressed his doubts as to ever being able to repay him, this good Samaritan cheerily remarked that he "need not trouble himself about that," but whenever he needed further assistance to call upon him.[†]

Writing of his circumstances at this time, in the early part of 1836, he says:

> For several months my prospects of getting assistance for a trial on a large scale, looked very dubious. My friends seemed to be worn out and tired of my talk about electro-magnetism being used as substitute for steam. Many hundreds of ingenious mechanics and wealthy people had seen the power propel machinery of various kinds, and all expressed a strong anxiety that I should persevere, and apparently wished with all their hearts that I might succeed. The great benefit it would have in saving human life was particularly mentioned by all who seemed to wish the project well, but yet I was totally unable to reach the purse strings of the capitalist. The objection urged by many was that my letters patent had not been taken out, and when I informed them that the patent could be obtained as soon as I could raise the

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[*] The author desires to express his acknowledgments to William Lincoln Smith, S. B., of the Massachusetts Institute of Technology, and W. A. Hovey, of the American Bell Telephone Company, for making an examination of the files of the Boston papers, and to Mr. Smith especially for the information obtained from Mr. Hall.

[†] The author regrets that he has been unsuccessful in the attempt which has been made by him to identify the Mr. Kimball whose generous conduct towards a needy and struggling inventor, entitles him to the grateful remembrance of all electricians.

means sufficient for that purpose, the reply was that I had delayed so long already that some other person would probably anticipate me.

The necessities of Davenport's family now rendered it imperative that he should at once seek some means of livelihood. With characteristic persistence, he determined to attempt this by giving exhibitions of his circular railway and other electro-magnetic apparatus. His first entertainment of this kind was given in the public school-house in Brandon village. The occasion is well remembered by aged residents of that place who are still living. The building in which the exhibition took place now forms a part of the residence of George Parmenter, Esq., and, it may be remarked in passing, enjoys the further distinction of having been the school attended by Stephen A. Douglas, a native of Brandon, in preparation for college, he supporting himself meantime by working at the trade of a cabinet maker.

During the following summer Davenport exhibited his apparatus two weeks at Saratoga Springs, which even at that early day had come to be somewhat of a resort during the warm season for wealthy people from various parts of the country. While here he formed the acquaintance of a leading citizen of the place, the late Ransom Cook, who was at that time a prosperous manufacturer, and proprietor of an extensive shop driven by steam power and supplied with superior machinery and tools for working both in wood and metal. Cook was profoundly impressed with the apparent value and importance of the invention, and at once tendered to Davenport the technical and financial assistance necessary to bring his enterprise properly before the public.

THE POSTAL TELEGRAPH CO. NOT TO SELL OUT.

A statement has been published that Jay Gould had purchased a controlling interest in the Postal Telegraph Cable Company. This report is so far denied. One of the officials of the company says:

"The report is entirely unfounded. Our stock is not listed on the stock exchange and there is none to be bought. This company was formed for the purpose of carrying on a legitimate business and not for the purpose of compelling the Western Union to buy us out.

"During the past two years we have built more than 4,000 miles of line, and we are now pushing rapidly toward New Orleans. As soon as that link is finished our system will extend from the Atlantic to the Pacific and from the great lakes to the Gulf of Mexico. We have direct connection with the Commercial Cable Company and the Canadian Pacific Telegraph. The gentlemen who own a controlling interest in this company do not wish to sell, nor do the Western Union Company wish to buy our property, for they recognize the fact that should they gain control of our system a new company would be formed within three months."

THE NEW ELECTRIC LIGHT AND POWER STATION AT LOWELL, MASS.

BY

A. C. Shaw.

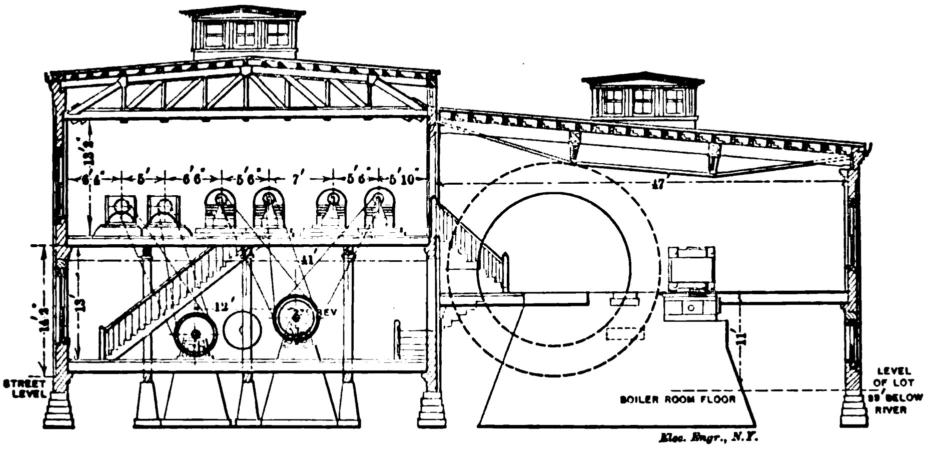


Fig. 1.—The Lowell, Mass., Electric Light Station.—Section of Engine and Dynamo Room.

No better proof of the commercial success of electricity as a producer of light and power can be adduced than the fact that so many cities are at last providing themselves with stations worthy of the name, and that engineers are giving their whole attention to the erection of stations which will not only produce the desired effect of making electric light and power reliable and popular, but which will be able to take care of the rapid increase of business, and at the same time have a chance of creating some dividend for the pocket of the stockholder. As another example of such a station, I take pleasure in presenting in detail the plans of the new electric light and power station at Lowell, Mass., which is now just being put into active service. Like most of the larger cities, Lowell has passed through an interesting history in the development of its electric lighting industry. The Lowell Electric Light Corporation was organized under the laws of Massachusetts, in 1881, with a capital of $10,000, and began business with two Weston arc light machines, leasing power from an accommodating sawmill. Business, however, did not thrive very well, and about a year later the Middlesex Electric Light Company was formed, and a small plant was built on Middle street. This company introduced the Thomson-Houston system, and shortly after effected a combination with the old company, under the same name, and continued to do business till about two years ago. At that time they reorganized under the name of the Lowell Electric Light Corporation, still continuing to use the Middle street station. Without going into details, it may be stated that they started at first with one 50 h. p. Armington and Sims engine, increased to three engines of the same manufacture, and then put in a 250 h. p. Harris-Corliss high pressure engine, remodelling the entire plant. Business continuing to increase, another addition was temporarily made, and then it was decided to build on an adjoining lot, and a 200 h. p. Atlas engine and another 300 h. p. Harris-Corliss engine were put in. In 1889, the alternating incandescent system was introduced, making an enormous increase in the demand for generating capacity, and a contract was entered into to furnish power for the Lowell and Dracut Street Railway Company, and it being at once seen that even the enlarged station was wholly inadequate to meet the requirements, it was decided to build a new first-class station, and accordingly land was bought on Perry street, near the river, where an abundance of water could be had for condensing purposes, it having been decided to adopt compound condensing engines, and build the plant on the most economical principles known. Their capacity at that time was about 800 h. p., and they were running about 450 arc lights, 2,000 alternating incandescent lamps, and 50 h. p. in stationary motors; and they were supplying current for from three to twenty electric cars. The new station is designed for 3,000 h. p., and 1,250 h. p. is being installed at present. The boiler room, as shown in the plan, is 66 feet wide and 92 feet long, and there is accommodation for 16 boilers 72 inches in diameter by 17 feet long. The boilers are built of steel and are of the horizontal tubular type, with 140 three-inch tubes, and were manufactured by Scannell & Wholley, of Lowell, Mass., and set by the Jarvis Engineering Company, of Boston, with their patent Jarvis setting. As will be seen, the boilers are ranged on either side of the room and the smoke stack is inside the boiler room. This stack is square in outside section, is 175 feet high, with a 7-foot round flue running to within 50 feet of the top. The floor of the boiler room is paved with brick, and the roof is supported by eight cast iron posts, supporting trussed beams, with two monitor ventilators. A light track will be led through the middle of the room, and a small truck will be used to bring in the coal from the outside storehouse, which will have a capacity of 1,000 tons, and which is in communication with the neighboring Boston and Maine Railroad. All the hot water pipes for feed water, communicating with the pumps, heaters and boilers, are of brass. The boilers will be fed by one Knowles pump, one Worthington pump and one No. 50 Hancock inspirator. The steam piping, furnished by the H. R. Barker Manufacturing Company, of Lowell, varies from 5 inches diameter over the first boiler to 14 inches diameter in the main steam pipe, and will be covered throughout to prevent radiation, Chapman gate valves being used throughout. On the wall between the boiler house and engine room is a Locke damper regulator, and a combination of Crosby steam gauges, etc. The engine room measures 140 feet long by 45 feet wide, and is connected by staircase with the boiler room. There is also an inclined plane connecting the two rooms, which is concealed under a removable part of the floor, which forms a great convenience for the handling of heavy parts of the machinery. Starting next to the boiler room wall, there is one 250 h. p. cross compound Harris-Corliss engine, with cylinders 16 inches and 30 inches diameter by 36 inches stroke, belting in to the extreme end of the counter shaft. Next comes a 200 h. p. Atlas engine to be used only in case of emergency, and which is the only high pressure engine in the station. Beyond this engine is a space for a 1,000 h. p. tandem Corliss engine (double 500 h. p.) for increase, shown in the engraving but not yet put in. Next comes a 500 h. p. tandem compound Harris-Corliss engine, built by the W. A. Harris Steam Engine Company, of Providence R. I., with cylinders 22 inches and 40 inches diameter by 48 inches stroke. The flywheel of this engine is 22 feet in diameter with a 52 inch face, is built in ten sections and weighs 50,000 pounds. The belt is 48 inches wide and was made by J. E. Gates & Company, of Lowell, who furnished all the belts in the station, both for the engines and dynamos. Space has been provided for another 500 h. p. Corliss engine, and lastly there is a 300 h. p. cross compound condensing Harris-Corliss engine, with cylinders 18 inches and 24 inches diameter by 42 inches stroke, belting on to the other end of the shafting. The floor is of the ordinary balloon construction with 12x12 inch Georgia pine stringers, supported on brick piers 30 inches square, on top of the stringers 3x12 inch spruce timbers 20 inches apart on centres, then a 2 inch spruce planking and finished with 1 inch birch flooring. There are no posts in the engine room, the roof being trussed with three monitor ventilators. The foundations of the engines are all of stone, no brick being used, as a very fine grade of stone is easily procurable in Lowell. The floor level of the room or cellar in which the foundations are laid is on the level of the lot, so that there really is no cellar nor excavation, making the room quite light, and convenient for placing of the air pumps, circulating pumps and other accessories, of the engines. The stone foundations extend about eight feet below the level of this floor. In their room are two Knowles condensers for the two smaller Corliss engines, and directly below the 500 h. p. engine is a Harris-Corliss condenser and air pump operated by a lever connected to the engine above. The exhaust steam of the large engine passes through a 500 h. p. National feed water heater, Fig. 3, manufactured by the National Pipe Bending Company, of New Haven, Conn., which will raise the feed water to over 200° Fahr. before entering the boiler, and then passes to the jet condenser. A valve is provided to allow the exhaust to pass into the air if required, instead of going into the condenser. National heaters are also provided for the other two Corliss engines, and brass piping conducts the hot water back to the boilers.

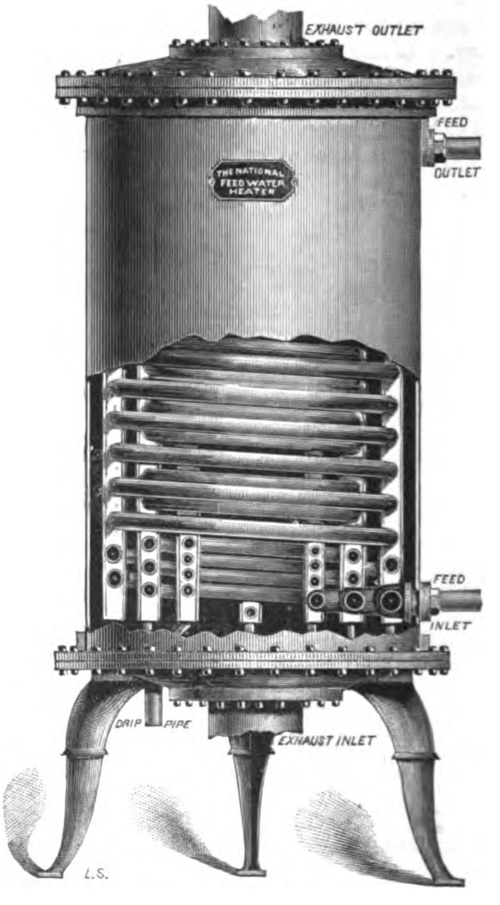
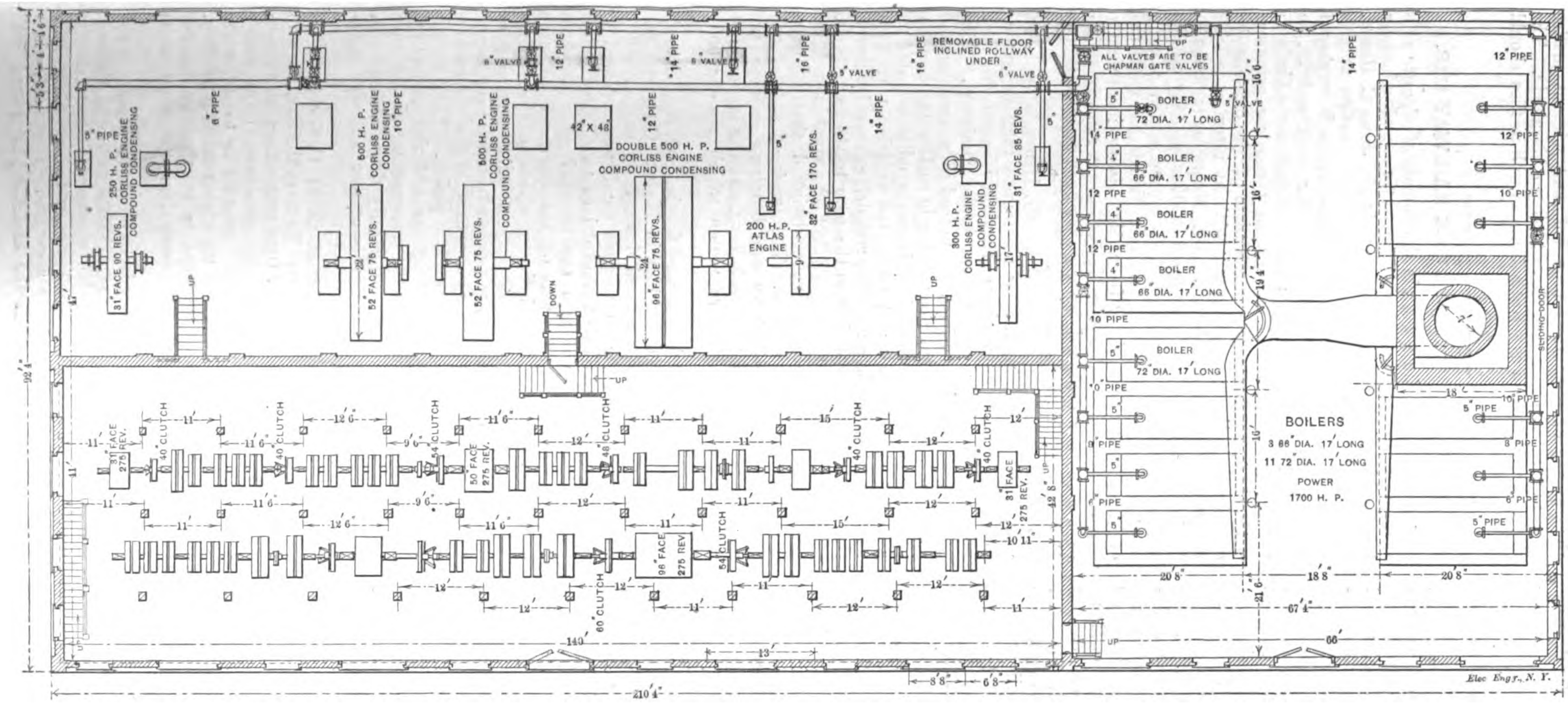


FIG. 3.—FEED WATER HEATER, LOWELL, MASS., STATION.

On the same level with the floor of the foundations of the engines, and on the other side of the building is the shafting room, which has been completely fitted up by Messrs A. N. Bates & Company, of 120 Pearl street, Boston. Special attention has been paid to make this shafting as perfect as possible, the very best materials and the best workmanship having been used. The foundations are of stone resting on a 12-inch bed of concrete made of broken stone and cement. The main journal bearings are supported on solid stone, and the other bearings on cast iron stands. The main pulley is driven from the 500 h. p. engine is 72 inches diameter by 50 inches face, and runs on a quill, so that the engine can be started without moving the shafting, and the strain does not come on the shafting. The belt from this engine passes under a heavy idler or



THE LOWELL, MASS., ELECTRIC LIGHT STATION.

FIG. 2.—PLAN OF ENGINE, BOILER AND COUNTER-SHAFT ROOM.

From the designs of Mr. H. C. Patterson, of the Thomson-Houston Electric Co.

belt tightener, manufactured by the Holyoke Machine Company, of Worcester, specially designed for this class of work. There are two Eclipse clutches, one 48 inch and one 54 inch diameter, on the quill, and there are four 40 inch Eclipse clutches, to subdivide the shaft into sections. The pulleys for driving the dynamos are of the slack and fast type, the slack pulleys running on special stands of the Holyoke Machine Company type, and not touching the shafting at all, the dynamos being provided with an extra wide driving pulley. The shafting is 6″ diameter and is made of steel, and no expense has been spared to make this part of the work representative in every detail. It may be mentioned that when the shafting was started up for the first time, it ran 17 consecutive hours, with a working load, without heating up in any way. The dynamo floor directly above the shafting room is supported by 33 12″x12″ Georgia pine posts. These support 12″x12″ Georgia pine stringers, with 4″x12″ spruce joists with 16″ centres, which in turn support 3″ tongue and grooved spruce flooring, which is then finished with 1″ birch. The dynamo room is 140 feet long by 47 feet wide. At the furthest end from the boilers, there is a small machine shop railed in, supplied with lathe and necessary tools for repairs, toilet room, bath room, men's room, and a small office for the superintendent, the executive offices of the company being in the city. On this floor there are 13 50-light Thomson-Houston arc light dynamos, two 50 h. p. 500 volt Thomson-Houston generators for stationary motors, four 100 h. p. Bentley-Knight railway generators, and two 1,300-light and one 1,000-light Thomson-Houston alternating incandescent dynamos. The arc dynamos are each set on hard pine base pieces, and the wall controllers are on the piers of the arched wall between the engine room and the dynamo room. The dynamo room is provided with a trussed timber roof with three monitor ventilators, two of which are used for wire towers. The station is wired throughout with okonite, furnished by the Pettingell, Andrews Company, of Boston, and almost all of the outside circuits are composed of P. & B. wire, manufactured by the Electrical Supply Company, of Ansonia, and supplied by the same company. The switchboards are all of the most improved skeleton type. The alternating board is arranged for three machines, with an extension to accommodate six; the arc light board is by itself, and a 500 volt board takes care of all the generators. Each room of the building is provided with stand pipe and hose in case of fire. The general design of the building is extremely neat and simple, and the whole building is well lighted throughout. As will be seen by looking at the sectional elevation, the engine room floor is six feet below the dynamo room floor and eight feet above the shafting room floor. Two stairways lead from the engine room to the dynamo room, one stairway from the engine room to the shafting room, and two stairways from the shafting room to the dynamo room. The wall between the engine room and the dynamo room is made of a series of arches, commencing on the level of the dynamo floor, with handsome moulded railing, so that anyone standing on the dynamo floor can see all that is going on both in the dynamo room and the engine room. The plans for the building were made by Mr. H. C. Patterson, of the Thomson-Houston Electric Company, and the whole work was carried out under the careful supervision of Mr. L. J. Fletcher, manager for the Lowell Electric Light Corporation, to whom my thanks are due for the foregoing details.

A NEW FORM OF METER REGULATOR.

BY

Alfred E. Braddell.

In the course of my duties while inspecting large numbers of electric light plants throughout Pennsylvania, New Jersey, etc., I come across many striking instances of derangement in the functions of electrical apparatus by purely accidental causes. When I say "accidental," I stretch the meaning of that word rather unduly, perhaps, for what we call accident is but too often the result of heedlessness, or carelessness, or the want of regular supervision. It stands to reason that apparatus which is closely watched, as all mechanism should be, is much less liable to get out of order and give trouble than that which is left to its own sweet will. Neglect quickly avenges itself in electricity as in most other things, and eternal vigilance is the price of steady dividends.

Some of these "troubles" that await even the most careful superintendent are very curious. I have just been given by the superintendent of an electric light station in my territory, a strange instance of the stopping of a meter, and of the explanation of its conduct. The meter in question was one of 20-light capacity. On going to read the instrument at the lapse of a month in order to determine, and charge for, the quantity of current used, he found that the consumer, in the pressure of business, had placed a mass of small boxes around the meter, concealing it from view. As it was desirable not to disturb them, it was suggested, and agreed to, that the meter be allowed to run another month. Upon the expiration of this time, the coast being clear, the meter was examined, and it was found that it had only recorded five hours during the whole two months.

This was suspicious, to say the least, but there was no ground to expect tampering, and so a very close inspection was made. It was then discovered that a spider had spun its web around the fans so that they could not rotate under the action of the current. It appears that the screw which holds the cover to the top of the instrument had not been put in, and, no doubt, the wily spider perceiving that he could secure a warm lodging free of rent, crept in through the opening thus provided, and without malice aforethought or otherwise, there took up his abode. The moral is that station superintendents as well as flies should beware of spiders.

THE NEW HENRY ELECTRIC RAILWAY CAR.

Among those whose work in the domain of electric railroading we have noticed from time to time, and who may be considered one of the pioneers, is Mr. John C. Henry. This gentleman's work deserves special mention at this time, not only on account of the original methods employed by him, but due to the fact that as far back as 1879, he advocated what is now again agitated and seems likely to become general, namely, a constantly moving armature with which the propelling mechanism of the car may be connected or disconnected at will without interfering with the motion of the armature. Mr. Henry as far back as 1884 operated an electric railroad in Kansas City on this plan and later in San Diego, Cal., a road which was in operation up to a year and a half ago. With the experience of his older work to draw from, Mr. Henry has recently become associated with the McKee street railway syndicate, and a car designed by him has been in operation at Rochester, N. Y., for some time.

The arrangements employed by Mr. Henry in his latest work are decidedly interesting from more than one standpoint, and the accompanying engravings illustrate his new motor truck and automatic car brake combined. The gearing, it will be noticed, is incased in a housing and runs in oil, the internal gear being in reality the housing itself. The single motor which is employed is mounted on a double swivel truck and connected positively to both axles, and by a single connecting rod, driven from its centre, the motion is transmitted from the gear to the car wheels.

The arrangement consists in effect of a combined motor truck and automatic car brake, so designed that the parts help to support one another. The truck consists of two cast steel frames which have side bearings on which the motor fields and armature shaft bear, and the arch shaped field magnets carry a centre pin on which the car body rests and swivels.

The gear employed is a modification of Mr. Henry's planetary gear as used by him in Kansas City and San Diego. The gear is mounted loosely on the armature shaft and inside of the housing is a small pinion keyed to the armature shaft. This pinion drives two intermediate pinions which engage with the internal gear A, which forms the housing. The pins of the intermediate gears carry with them an external disc E, which in turn drives the connecting rod from its centre. By clutching or arresting the internal gear, which is effected by pulling on the lever B, the intermediate gears turn on their own axes and around the axis of the armature pinion. This motion is transmitted to the connecting bar and the car wheel. When the clutch is released, the intermediate pinions turn freely on their own centres and only drive the internal gear A. In this position the car is at rest and the armature revolving freely.

The car is operated very much in the manner in vogue in cable railway practice. To start the car, the grip or clutch is applied gradually, thus preventing any abnormal current from entering the armature. On heavy grades, or with heavy loads, the practice is to allow the armature to revolve freely and the clutch to slip slightly, thus getting a yielding leverage in starting or hauling heavy loads; the motor at the same time operating at its best efficiency.

The armature of the motor is 18 inches in diameter and is of the Gramme type; it has a shaft 3 inches in diameter and is designed for about 35 horse power. The armature is wound with 500 turns of No. 7 wire, weighing 97 pounds, connected to 72 commutator segments. The field, which is connected in series with the armature, is wound with

No. 9 wire, having 90 pounds to each limb, thus making 360 pounds in all for the field. The construction is such that there are only two joints in the magnetic circuit. The armature is wound with one continuous length of wire, and loops are formed to receive the armature segments. The speed of the motor is regulated by commutating the fields and by slipping the clutch, as indicated above.

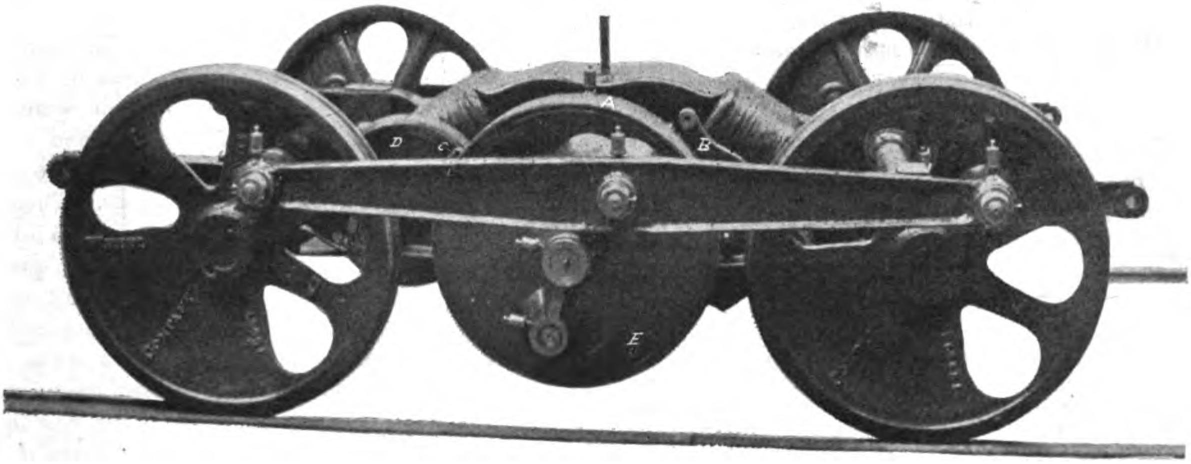


FIG. 1.—THE HENRY ELECTRIC RAILWAY MOTOR AND TRUCK.

The mechanical construction adopted is also worthy of notice. Thus the commutator can be removed in a very short time, as no solder is used in the construction of the machine. It will also be seen that by sliding the armature endwise on the shaft in one direction, and the fields on their supporting bars in the other direction, the armature can be entirely exposed and rewound or repaired without removing the field or taking it off its bearings. Both the car axles and the armature supports are $3\frac{1}{2}$ inches in diameter and are thus of great strength and stiffness.

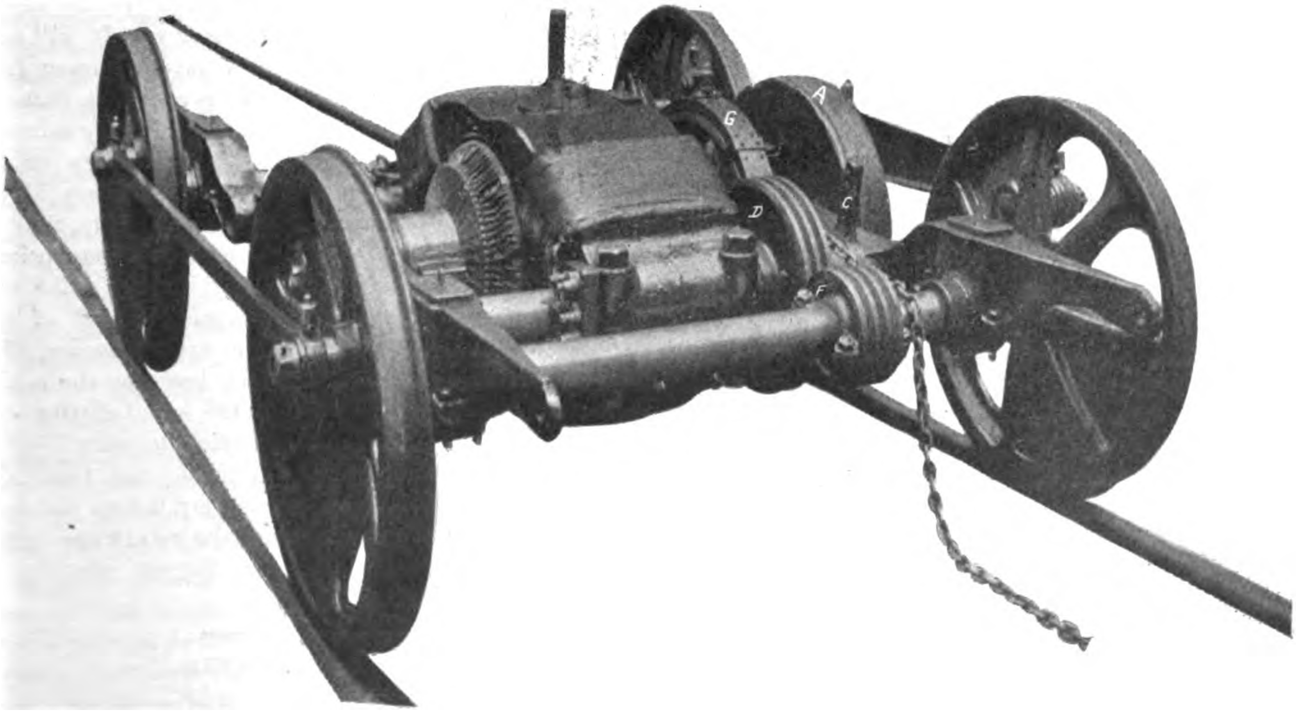


FIG. 2.—THE HENRY ELECTRIC RAILWAY MOTOR AND TRUCK.

We come now to another essential part of the arrangement, and that is the brake, which is supported by, and forms a part of, the motor truck. It is of the automatic type and consists of a V-grooved friction wheel F secured to the car axle, and a loosely mounted correspondingly V-grooved wheel D on the motor support. An eccentric operated by means of the lever C throws the wheel D in engagement with the friction wheel F and thus winds a brake chain which is connected to the ordinary brake shoes of the motor and to those of the trail cars. By this means the movement of the car is employed in applying its own brakes, thus relieving the driver of all severe exertion, the mere throwing of a lever similar to the one employed for throwing in the driving gear, being sufficient to apply the brakes. It will be evident that by disconnecting the driving machinery from the car axles it is much easier to stop the car, as the momentum of the latter need not then to be overcome in addition to that of the car itself, as is now the case. It will thus be seen that only two levers are employed which, under the control of the driver, perform all the operations requisite for the handling of the car.

The motor which we have just described was designed and constructed by Mr. Henry, and tested by the McKee syndicate with eminently satisfactory results. Owing to the constantly running armature and the small number of moving parts, as well as the thorough lubrication, the commercial efficiency has proved to be very high. The machine, although subjected to the most severe tests, has successfully stood the heaviest strains, and preparations are now actively going forward to introduce Mr. Henry's car arrangement on a large number of railways.

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VOL. XI. NEW YORK, JANUARY 14, 1891. No. 141

Let the imagination go, guarding it by judgment and principle, but holding it in and directing it by experiment.—Faraday.

ELECTRIC LIGHTING IN NEW ENGLAND.

WE publish in this issue another of Mr. A. C. Shaw's interesting descriptions of modern New England central stations. This illustrated series, which has attracted considerable attention, has brought out a number of points, and has shown throughout how remarkably inadequate all the early New England stations were. All of these enterprises began under humble conditions—Worcester in a basement, Lowell taking its power from an accommodating sawmill—and all soon found their equipment short of the necessities, until to-day, by successive and rapid strides, after having made frequent additions, they see that the best thing is to begin absolutely anew with such an outfit as the evolution of the art and the latest practice recommend.

In one or two previous discussions of this subject, we have dealt with it, chiefly and naturally, from the standpoint of the local lighting company. But another view of the case forces itself upon one's notice. A moment's thought will show that the great reason for these rapid extensions and rebuildings has been the immense popularity of the electric light in New England, where there are practically more local electric light plants than there are gas works. It is true that New England has from the first been canvassed with special energy by parent manufacturing companies with electric light apparatus to vend, and that the local managements have been very assiduous in pushing their business; but all this enthusiastic onrush would have been dulled and defeated were it not for the prompt appreciation that the New England public evinced toward the new illuminant. Besides, the New England stations, as a whole, have been peculiarly free from accident, and the rates have been moderate. Hence a desire to sell was seconded by a readiness to buy, so that the weird electric influences which according to Dr. "Joe" Cook have always been strongest in the north-easterly sections of this country, must have been marvellously intensified by the springing into existence of innumerable circuits and the daily distribution for light and motion of thousands of electric horse-power.

It seems to us, however, that New England is reaching a notable economical crisis in the progress of its electric light industry. We have recently been watching the annual addresses and reports of New England mayors to see if there were any trace of the movement towards the municipal ownership of electric light plants. There are not so many indications as we expected but enough to suggest the desirability of being ready to deal with the question, if private enterprise is to be stimulated and not quenched. One encouraging feature is that in every instance the electric lights are well spoken of, and that while in some instances the city councils are advised to go slowly in meeting the applications from citizens for new lights, in others an increase in the service or in the hours of lighting is suggested.

But the gravity of the situation, for those who wish to see more of these fine stations springing up in New England, is demonstrated best by the passage in the message of Governor Russell, of Massachusetts, wherein he proposes that towns and cities shall be granted more latitude than they enjoy now in regard to "municipal control of municipal work and ownership of the instrumentalities for its performance." Our New England friends should be preparing themselves for the emergency. It will be a fight not for their modest dividends but for human freedom, and for the abstention of the government, State or municipal, from every unessential duty and every unnecessary tax. It is an amusing, but sad, commentary on the situation referred to that in New York city, where Mayor Grant has also been proposing municipal ownership, the only decent street cleaning is that done by the citizens' private enterprise, and that in Baltimore, which also talks of a municipal electric light plant, a company formed of local business men has offered to do the street cleaning effectively for $175,000 a year or $100,000 less than the municipal establishment costs. But then the new lighting plant will provide $20,000 worth of new offices to control politically, so Baltimore's practical politicians and theorizing professors, with intermingled tears of joy, hasten to help in setting up another tyranny. Thus are we always signing Declarations of Independence and forever placing our neck under new yokes.

TELEPHONE RATES.

UNDER the above heading our estimable contemporary, *The Electrical World*, takes occasion to admonish the Metropolitan Telephone Co., and by implication the managers of the telephone service in other American cities, in the matter of charges. Results of the service under government administration in Germany, particularly in Berlin, where the annual rental to subscribers is given as 150 marks, about $37.50, and where the service is said to be fairly satisfactory, are offered to justify a note of warning to the American telephone companies of the possible adoption of a government postal telephone system to supply the public cheaper and better service. After noting the establishment of telephone communication between Berlin and Bremen, at charges "from 25 to 50 cents *per message*," *The Electrical World* makes comparison with the rate between New York and Boston for *five minutes conversation*—which it mistakenly states as $2.50 instead of $2.00—and says "the rates now charged could be much reduced and the business would still yield a good profit, at least what would be considered a good profit in any business that does not partake of nature of a gigantic monopoly."

This expression of opinion seems infelicitous, both in its inference from the German figures and in its indirect attack upon property in patents.

As between this country and Germany, even if there existed an equality of conditions and a parity in the quality of the telephone service, no legitimate conclusion as to the equity of the German rates could be drawn in the absence of a balance-sheet showing how much profit or loss attends the administration of the telephone service—whether any deficiency falls upon the tax-payers. The subscriber's rental of $37.50 prevails not only in Berlin and other large cities, but throughout Germany, in small towns and great. We have trustworthy information that the Berlin service is conducted at a very considerable annual loss; the deficiency must be made good from taxes, or, which comes to much the same thing, or worse, from any profit that can be derived from the service in much smaller towns. The uniform German rental is about equal to the lowest rate charged in this country—in the small towns and villages. After deducting royalty, a charge not incurred by the German administrations, the American local company supplying service at $36.00 or $42.00 per year in small towns gets less than the German rate.

We shall not here point out the several marked differences in conditions touching such an industry as the telephone service in Germany and the United States, such as a ratio of about 1 to 3 in the wages of operators, nor dwell upon the persistent and intelligent efforts and vast expenditure that the leading telephone companies, including the long-distance company, are devoting to the provision of improvements in construction and apparatus and the amplification of facilities for the public. Our larger exchanges, as New York, Boston, Chicago and Philadelphia, are pushing forward the execution of well considered and far-reaching plans for underground wires with general systems of metallic circuits, and bringing to bear upon them the most advanced knowledge and practice of the art of the telephone engineer, and at a cost that would be a revelation to that thoughtless portion of the public—happily lessening, we believe—who deem the telephone companies oppressive in their charges and indifferent to the quality of their service. We do not think that any considerable number of the people who use telephones want the service in part at public expense, much less at the expense of other subscribers in different localities. No paternalism is wanted here; paying for what one gets is still the preferred way.

Our contemporary's use of the term "gigantic monopoly" is to be deplored for its implied assault upon patent property. Our readers do not need to be reminded that in its very nature and essence a patent bestows upon its rightful owner exclusive use and control of an invention for a definite period of time; nor do they need to be told that the rewards possible under the rights conferred upon inventors by our patent laws have been a chief factor in stimulating the achievement of our industrial prosperity. If a patent be in a proper sense a monopoly, "it is not," as a distinguished judge once said, "an odious monopoly." The distinction between patents and monopolies has never, perhaps, been better presented than in the following words, from the opinion of Justice Giles, in the sewing machine case, Singer vs. Walmesley: "Patents are not monopolies, because a monopoly is that which segregates what was common before, and gives it to one person or class for use or profit. A patent is that which brings out from the realm of mind something that never existed before, and gives it to the country."

THE ART OF ELECTRO-DEPOSITION.

Electro-deposition of pure copper from copper matte has already assumed such proportions in this country, and the indications of its large growth in the future are so unmistakable, that the exact conditions involved in work of this nature ought to be generally known, so that the greatest possible economy in the working of the process may be obtained. Up to the present time this class of work has been confined to but comparatively few firms, who have for the most part kept their methods secret, and though the general principles are well enough known, the details are by no means matters of general knowledge. Judging, too, from recent publications abroad, there is a decided lack of knowledge there on certain important points in connection with the process and especially upon the best method of the arrangement of the vats. Our readers will therefore find in the article by Mr. C. O. Mailloux a succinct and accurate statement as to the factors governing many important points in electro-deposition, and the conditions to be fulfilled in order to attain any desired result. Mr. Mailloux's statements being based upon the results of his own actual practice and personal experience, are worthy of the closest attention, and we hope they will set right any misapprehension that may now exist on the points involved.

Electric Railway Underground Conductors.

To the numerous plans which have been proposed for running electric railway conductors so as to avoid the necessity of using overhead wires, we add this week another, due to Mr. F. Mansfield, by which the inventor hopes to meet some of the difficulties which our rigorous climate imposes upon such a system. Having in mind the fact that the accumulations in a conduit may easily become of such a nature that their removal is practically impossible through the ordinary channels provided for the drainage of the conduit, he proposes a system in which that contingency is met with by running an insulated conductor below the surface and connecting it at regular intervals with the device which is closed mechanically by the car in its passage over the road. The manner in which the details of the system have been worked out by Mr. Mansfield is decidedly interesting, and it is to be hoped that an early opportunity may be found for giving the system a practical trial.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—IX.

(*Copyright, The Electrical Engineer.*)

BY

Herbert Laws Webb

TEST FOR INSULATION.

THE connections for the insulation test are shown in Fig. 30. It will be seen that almost the only difference between this and the preceding diagram is that the cable takes the place of the high resistance. In taking the galvanometer constant, however, it makes no difference whether one side of the battery key and high resistance are put to earth or connected directly together,* but in making the test for insulation one side of the battery must, of course, be put to earth, as it is the dielectric of the cable that really takes the place of the high resistance and the dielectric is in contact with the earth in the natural course of events.

Before the cable is connected to the lead the instruments and lead should be tested for leakage by turning on the the full battery power and opening the short circuit key, no shunt being inserted in the galvanometer circuit. If any deflection is observed it should be noted under the heading of "leakage from lead," and the amount of this deflection should be deducted from that given by the cable. It is important that all the instruments be kept clean and dry, and that the wire used for connecting them and for the lead have a high insulation. The leakage from the instruments and lead should not be more than a few divisions, ten at most; if much more than this is observed the connections should be overhauled, and the trouble remedied. It can readily be ascertained whether the leakage, if an undue amount is observed, is in the lead or the instruments by disconnecting the lead entirely and testing the instruments alone.

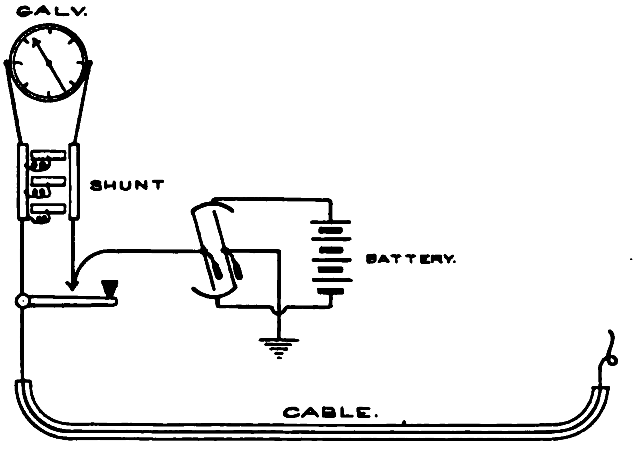

FIG. 30.—CONNECTIONS FOR INSULATION TEST.

Special attention should be paid to keeping the leads in good order; the testing room ends, being connected to the insulated binding posts, need never be touched, but the ends that are joined to the cables or wires to be tested should be trimmed occasionally, the insulation being tapered so as to expose a considerable surface between the wire and the braiding; the attendant who makes the connections should be instructed not to handle the lead near the extreme end but to hold it about six or eight inches back; if the end of the lead is handled much the insulation will become soft and perhaps damp, giving rise to surface leakage. When testing submarine cables, or wires submerged in a tank, both ends should be carefully trimmed and the insulation coated with hot paraffin for a short distance back to prevent surface leakage.

The insulation of the instruments and lead having been tested and found "O K," the cable is connected to the lead and the current turned on by means of the battery key, the zinc pole of the battery being applied first. A few moments after turning on the battery the short-circuit key should be depressed, throwing the galvanometer into circuit. The short-circuit key should always be left closed when the current is first applied to avoid sending a sudden charge through the galvanometer, which would cause the needle to be violently deflected and perhaps partially demagnetized.

It will be observed that the deflection obtained, instead of remaining steady, as with the constant, gradually decreases; the resistance of the dielectric being apparently augmented by the application of the current. This phenomenon is called *electrification*, and no clear and satisfactory explanation of its cause is forthcoming, although it is attributed to a sort of polarization of the insulating material by the action of the current. Electrification is especially marked with homogeneous dielectrics, such as gutta-percha and india rubber; it is greater with the latter, than with the former and with both materials it is greater at a low than at a high temperature.

With cables having a dielectric of fibrous material saturated with paraffin or resinous compounds electrification is very rapid for the first minute or two and subsequently very slow, or almost stationary. A cable of this description if subjected to a temperature sufficiently high to lower the insulation to any considerable extent will not show any electrification at all, the deflection remaining practically constant however long the current is kept on. A steady deflection and gradual electrification are signs of a good cable; absence of electrification, oscillations and kicks of the spot denote the reverse. In testing submarine cables, or rubber covered wires submerged in water, special attention should be paid to these indications. The deflection may be steady and show fair electrification, but if any sudden kicks are observed, even though they be very small ones, they may be taken as an almost sure indication that the wire or cable has an incipient fault which will probably be completely broken down, or at any rate developed sufficiently to proclaim its existence beyond doubt, by the steady application of the zinc pole of a battery of several hundred cells.

Another sign of a good cable is that it should give equal deflections with both poles of the battery. The zinc current is always applied first as it has the effect of accentuating any fault or incipient defect, and as a general rule the readings with the zinc pole are considered a sufficient indication of the condition of the cable; but if any weakness is suspected the cable is thoroughly discharged by being connected to earth for some time after the zinc current is discontinued, and a set of readings are taken with the copper pole of the battery to line. These readings should correspond with the first; if they do not—provided the cable has been completely discharged between the two applications of current—the test is not considered satisfactory and the cable will probably not last in good condition for very long.

These refinements in cable-testing are scarcely applicable to every-day work, but should always be applied when testing cables at a factory for acceptance or rejection, as the various points enumerated above throw considerable light on the specific quality of the dielectric and its prospective durability. It is not to be imagined that any relaxation of careful methods is advocated in every-day work, but it is not generally necessary in making periodical tests to take reversals or to take more than one minute's reading with the zinc current on each wire, except in the case of new cables or when a fault is suspected.

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* In Fig. 29, the connections are shown without earth.

THE BAXTER STATIONARY MOTORS.

In our last issue we described the new electric street railway car arrangement designed by Mr. William Baxter, Jr., of Baltimore, in which an 8-pole machine was ingeniously disposed under the car as the driving mechanism.

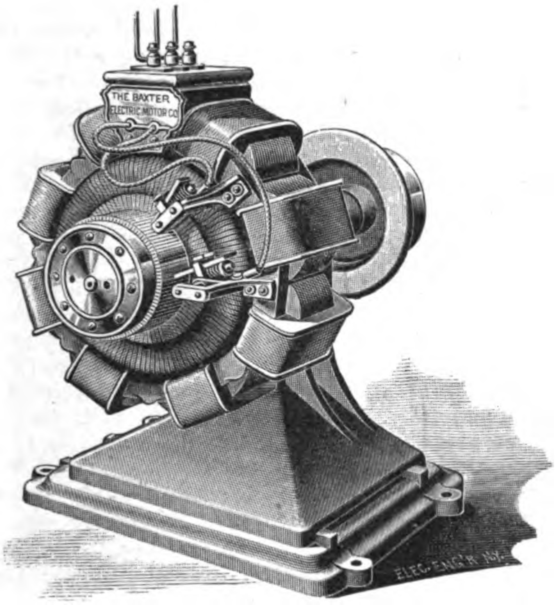
THE BAXTER
ELECTRIC MOTOR CO.
ELEC. ENG'R. N.Y.

Fig. 1.—The Baxter Constant Potential Motor.

Mr. Baxter has also carried out the multipolar construction in a complete series of stationary motors both of the constant potential and constant current type, and has introduced a novel construction of machine by which greater simplicity and accessibility to all the parts is attained.

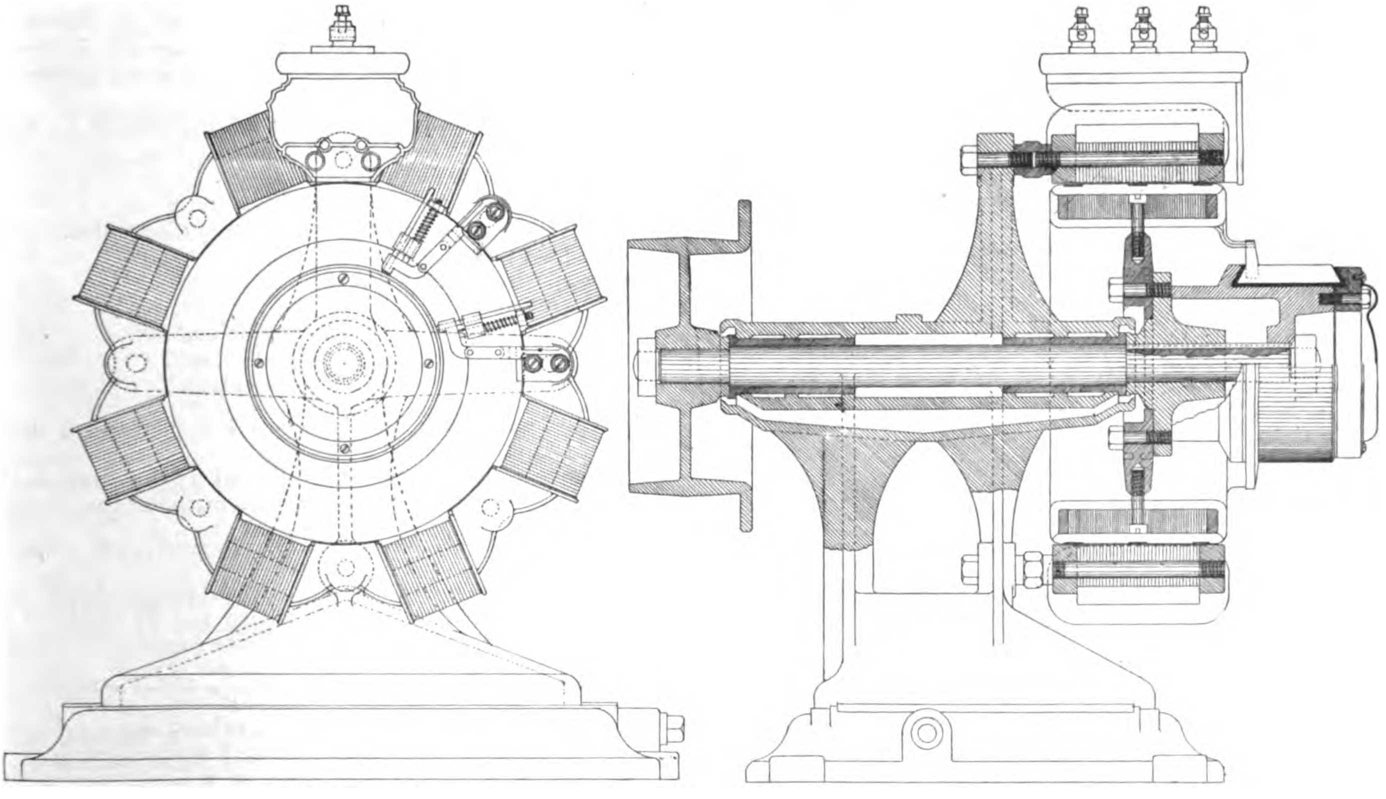

Fig. 2.—Elevation—The Baxter Constant Potential Motor—Fig. 3—Section.

The accompanying engraving, Fig. 1, shows the new constant potential motor in perspective, and Figs. 2 and 3 show an end view and section of the machine. The eight pole pieces of which the fields are composed are of the consequent pole type and all are thoroughly laminated. Mr. Baxter in these machines also employs the toothed armature with a very small air space, as the absence of wire at the periphery allows the armature to be brought very close to the fields. A long shaft is employed bearing at both ends and carrying at one end the pulley and at the other the armature. By taking the pulley off and removing the brush holder, the armature can be entirely slid out from the field and inspected or repaired with ease.

The field magnets are connected to the frame by a bracket connected to the four like poles, so that no tendency to leakage can occur, which indeed is also prevented by the interposition of brass intermediate pieces. The brushes, it will be seen, are placed at an angle of 45 degrees and are fixed in position, the machine being so designed that no shifting of the brushes is ever necessary. The 8-horse-power machine which is designed for 500-volt circuits has an armature 14½ inches in diameter and 6½ inches wide. It is wound in 136 sections of 10 turns each with No. 14 wire. Its resistance is 1.15 ohm. Each field magnet has a cross section of 5¾ square inches and is wound with No. 23 wire, the total resistance of the fields being 1,100 ohms.

The section of the machine, which is designed both as a dynamo and motor, shows clearly the method of supporting the armature and the field magnets. The armature, it may be mentioned, is wound with flat wire which permits of economy in space in wiring. The motor being automatic in its regulation requires no auxiliary regulator, and only three binding posts on top of the machine connect with the starting switch

The machines of this type are built in capacities of from 3½ h. p. to any desired size. The arc machines now being built by the Baxter Electric Motor Co., of Baltimore, are similar in design to the machine just described, but have a third brush which is moved by a governor placed inside the commutator and the motion of which is transmitted by a lever so as to move the third brush to keep the speed constant. These latter machines are also built over a large range of capacities. This type of machine allows of very compact construction, and, being multipolar, slow speed is obtained without sacrifice of efficiency.

ON THE ARRANGEMENT OF VATS IN ELECTRO-DEPOSITION.—I.

BY

C. O. Mailloux.

SOME thirteen years ago, M. Gramme, in France, and Mr. N. S. Keith, in this country, both advanced the theory, based upon experimental facts, that the power expended in depositing copper electrolytically, can be reduced indefinitely by increasing the number of depositing vats connected in series. The account of M. Gramme's experiments on copper deposition, submitted to the Académie des Sciences in 1877, by M. Hippolyte Fontaine,[1] contains what is perhaps the first mention of this theory in the statement or commentary "that with a fixed expenditure of power, it is possible by means of suitable arrangements to almost indefinitely increase the total deposition." Although referred to and commented upon afterward, this proposition does not seem to have been questioned until the summer of 1883, when the present writer was taken to task by a correspondent in the *Engineering and Mining Journal*, for having endorsed it in his article on "Electrolysis in the Metallurgy of Copper, Lead, Zinc and Other Metals," prepared for, and published by, the U. S. Geological Survey Department.[2] No attention was paid to the objections then raised, revealing as they did, a rather opaque knowledge, not to say a complete ignorance, of the electrical principles involved.

The theory has recently been assailed, however, by seemingly competent authorities in England, and has given rise to a controversy between this journal and one of its English contemporaries. The previous acceptance of this theory by the writer, as just indicated, and his experience of several years in the electro-chemistry and electro-metallurgy of several metals, more especially copper and lead, are his apology for presenting a few observations bearing on the points in controversy. If additional excuse were wanted it would be the writer's surprise that, at this late day, such a simple matter should be so obscure, when the magic touch of Ohm's law can make it clear so easily.

There are certain fundamental principles in electrolysis that are established definitely as the result of scientific demonstration, and are consequently admitted by all. It is, for instance, regarded as a fact that the electro-chemical relation or "equivalence" of a given current is definite, and constant for each element, the same as its atomic weight. This equivalence, in the case of copper, is, according to recent accurate determinations, said to be 0.32709 milligram per coulomb. Remembering that 3,600 coulombs are equivalent to an ampere-hour, and taking the kilogram as = 2.2046 lbs., we may express the equivalence, *i. e.*, the amount deposited, per ampere-hour, in any of the following ways:

1 ampere hour = 1177.5 milligrams.
" " = 1.1775 gram.
" " = .0011775 kilogr.
" " = .00259592 lb.

Instead of stating the equivalence as so much per ampere-hour, we may state it reciprocally as so many coulombs or so many ampere-hours per kilogr., or per lb. A simple calculation gives:

1 kilogr. = 849.2 ampere-hours.
1 lb. = 385.2 " "

This equivalence might also be stated by saying that the copper deposited from a suitable solution by the passage of an electric current varies in *rate* with the rate of current passing and in *amount* with the quantity of current sent through; the ratio being always constant and of the numerical value given above.

If a large current is used the deposit will be at a more rapid rate, and the time required for a given weight will be correspondingly reduced. Thus, a current of one ampere will require 385.2 hours to deposit one pound of copper, while a current of 385.2 amperes would do it in one hour.

The amount of deposit is, then, a measure of the *quantity of current* which has been allowed to act on the depositing surfaces, in an electro-depositing cell. It is by no means, however, a measure of the *amount of energy* involved. Each unit of current has, in passing through the depositing cell, recorded or registered itself by depositing a unit mass of the particular substance, copper for instance, just as each unit quantity of water or gas registers itself in passing through a meter. In either case the "record" gives no information whatever as to the amount of energy present. To estimate this we must consider an additional factor, the electrical pressure. The electrical energy consumed by the current sent through a depositing cell, is, therefore, measured just as in ordinary metallic circuits, by the product of the rate of current flow (C) and the pressure (E). It is easily seen now that in electro-deposition generally, the amount of energy will, *for a given current*, vary with the potential difference required to impel that current. If, then, it can be shown that this loss of potential is not fixed for that given current, but is susceptible of variation, it follows at once that the power consumed per unit weight deposited is not fixed either, but is capable of being controlled by changing the conditions. To this end let us briefly analyze these conditions.

The loss of potential in any electrolytic action proceeds from two causes: First, the portion needed to overcome dead or "ohmic" resistances in the liquid and solid bodies composing the circuits; second, the portion absorbed in overcoming the "live" or polarization resistance resulting from the chemical reactions produced at either, or both, electrodes by the current passing through the cell. The first portion of the loss will vary directly as the current density. The second also varies with the current density but to such a slight extent that we may, for the present, regard it as constant.

To make these and other relations of the principles involved more readily apparent, we may express the conditions in symbolic language by letting

r = resistance of electrode plates.
R = resistance of electrolyte between electrodes.
ε = polarization factor.
ρ = spurious resistance.
C = current.
E = potential difference at terminals of cell.
W = energy consumed in deposition cell.

The value of r, the resistance of the plates, is determined by the well known formula $\frac{l'\,s'}{a'}$ where l' is the length, and a' the sectional area, of the path followed by the current, s' being the specific resistance. In like manner the liquid resistance R can be expressed as $\frac{l\,s}{a}$. In reality, however, the current follows many different paths through both the electrodes and the electrolyte. Hence the symbols l' l, and a' a, must be understood to indicate average or mean values; or, more properly, the terms $\frac{l'}{a'}$ and $\frac{l}{a}$ must be taken to signify *effective* or resultant values, which latter will usually be *less* than those obtained by applying the above formulæ in the ordinary way, as a little reasoning will easily show. The *effective* resistances r and R, will, in consequence, be both slightly less than their calculated values unless the formula is modified by having recourse to the calculus.

Since the total dead resistance of the cell is $r + R$ the loss of potential occasioned in this resistance by a given current C will be:

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[1] Comptes Rendus, August, 1877.

[2] "Mineral Resources of the United States." Edited by Albert Williams, Jr., U. S. Geological Survey Dept., 1883. pp. 627-658.

$$= C\,(r + R) \qquad (1)$$

The current will induce chemical reactions at both electrodes, causing the metal surface of the anode to be dissolved, while a deposit is produced at the cathode. The principles of thermo-chemistry show that the chemical actions taking place at the anode require energy to be added to, while the actions occurring at the cathode will (normally) require energy to be removed from, the substances taking part in the respective chemical combinations. The electrical current, being the agency by which the energy is transferred, must supply the "deficit" at the anode and take up the "surplus" at the cathode. The difference between the two is the net gain realized, or, as the case may be, the loss sustained, by the current in doing the electrolytic work proper. In electro-deposition the difference is generally a loss. The phenomenon of "polarization" is both the evidence and the measure of this loss. The energy required to make up the loss is abstracted from the electrical energy of the current by causing a reduction in the potential, the effect being the same as if the polarization caused a back pressure or counter E. M. F. which we will designate by ε. The polarization might also be expressed as a "live" or spurious resistance ρ, whose value is taken such that $C\rho = \varepsilon$.

The total potential difference E required at the terminals of the cell to force the current C through it can now be written, as the sum of the two losses noted above:

$$E = C\,(r + R) + \varepsilon \qquad (2)$$

or else

$$= C\,(r + R + \rho)$$

The energy consumed in the cell will be

$$W = C^2\,(r + R) + C\varepsilon \qquad (3)$$

This equation applies to all cases of electrolysis in general. In the particular case of copper the factor ε happens to be exceedingly small.

As our object is to make a general and comprehensive demonstration, let us treat this factor as if it were of importance, as it often is with other metals, like nickel for instance. In part II we will see if it is possible to vary the consumption of energy while keeping the deposit constant.

THE DISSOCIATION OF CARBON DIOXIDE GAS BY THE ELECTRIC SPARK.[1]

An interesting paper is communicated by Prof. von Hofmann, to the current number of the *Berichte*, upon the dissociation of carbon dioxide gas into carbon monoxide and oxygen by means of the electric spark. Dalton and Henry long ago showed that carbon dioxide, although formed by exploding a mixture of two volumes of carbon monoxide with one volume of oxygen by the passage of an electric spark, is again partially decomposed into carbon monoxide and oxygen by the continued passage of the spark. Prof. Hofmann has now determined the exact conditions under which the explosive recombination occurs. The most suitable distance apart of the platinum terminals appears to be between two-and-a-half and three millimetres, and Prof. Hofmann advises the use of adjustable terminals rather than the ordinary platinum wires fused into the side of the eudiometer. A Leyden jar in the circuit renders the occurrence of periodical explosions more certain. The spark should also pass at about a quarter the height of the gas column instead of, as usual, near the top. The current itself, moreover, should not be too strong; that from two Bunsen cells and only a moderate sized Ruhmkorff coil yields the best results. It is also preferable to use a volume of carbon dioxide, previously dried over sulphuric acid, not exceeding ten cubic centimetres at a pressure of 650-700 mm. Under these conditions, the first explosion usually occurs in about 15-20 minutes. The second and succeeding explosions occur after shorter intervals than the first. This experiment is certainly one of the most interesting in all the range of dissociation phenomena.

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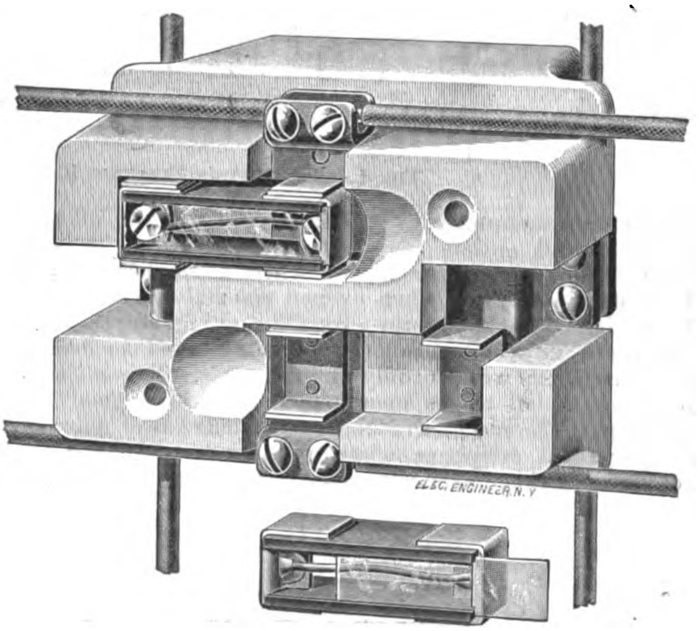
[1] *Nature*.

THE BURNET BRANCH BLOCK AND CUT-OUT.

Much difficulty has in the past been experienced in the replacing of fusible cut-outs in branch blocks when an overload has caused the blowing of the fuse. In order to simplify this operation Mr. H. W. Burnet, of East Orange, N. J., whose double pole switch was recently described in these columns, has designed the block illustrated in the accompanying engraving.

In this block the fusible wires are encased in separate boxes. One of these is shown in position in the block and the other below it. As will be seen, it consists of two side strips of vulcanized fibre which are held firmly together by two end pieces of brass. The top and bottom of the case are covered with mica, which fits in grooves, thus permitting the opening of the box at any time. To the brass ends of the case the fuse wire is soldered, or, if desired, it can be connected by screws, both forms being shown in the engraving.

The little case so constructed is slipped into a pair of clamp contacts provided for it. As a result, if the fuse should blow, the little case can at once be removed and replaced by a fresh one; or the fuse wire can, if desired, be renewed in the old one.



Burnet's Branch Block and Cut-Out.

The enclosing of the fusible wire in the insulating case prevents all danger of fire from flying particles of molten metal and at the same time allows of the inspection of the fuse wire at all times, without the removal of any covering parts. It will also be noted that the branch wires are thoroughly protected from contact with one another.

Among the other advantages of this block are that the wires may be run directly and the block inserted afterwards, or vice versa, as by the construction it is evident that neither the branch nor the main wires need be cut. The construction also admits of the easy connection of wires and allows of their being drawn taut at any time afterwards. Where the fuse wire is secured by screws any desired size may be inserted. The block illustrated is made in various sizes for branch and main cut-outs.

THE NATIONAL SYSTEM AT JAMAICA, L. I.

A plant of the alternating system of the National Electric Manufacturing Co., of Eau Claire, Wis., has been put in at Jamaica, L. I., by the Jamaica Gaslight Co., a corporation of 40 years standing. The plant comprises a 1,000 light dynamo, with a 100 h. p. engine and a boiler of 125 h. p. Three hundred lights is the figure at which the plant starts off, and the Brooklyn *Times* reports the installation and the results to be very satisfactory.

MANSFIELD'S UNDERGROUND ELECTRIC RAILWAY SYSTEM.

Although the desirability of replacing the overhead conductors of the electric railways in our large cities is well recognized, the construction of a proper underground system to take the place of the former is by no means an easy problem. One of the principal obstacles to be overcome in an underground system is the short circuiting of the conductors by moisture. The extent to which this occurs depends upon the amount of moisture in the street and the number of cars out. Whenever salt is used in the street, even in small quantities, the trouble is greatly aggravated. When slush covers the street the difficulty is almost insurmountable. The slush will not run off and chokes up all outlets for the escape of water, as was recently demonstrated in Boston where a number of manholes or catch basins when opened resembled a barrel of flour filled to the brim; the slow filtering of water through the increasing accumulation of snow had packed the basins solid and many were entirely unserviceable. This is liable to happen to all basins upon which conduits depend for drainage. The recent weather when thousands of miles of telegraph and telephone wires were rendered useless on account of leakage even with very low potential shows how imperative it is to have all exposed parts of an electric railway system reduced to a minimum.

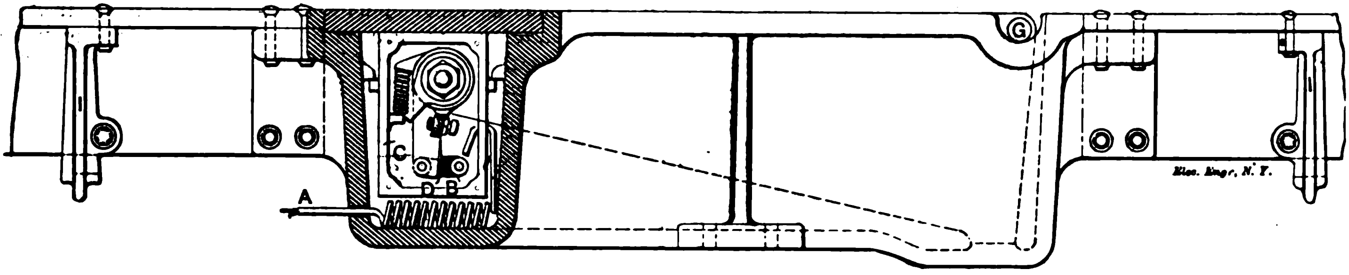


Fig. 1.—Mansfield's Electric Railway Underground Conductor System.

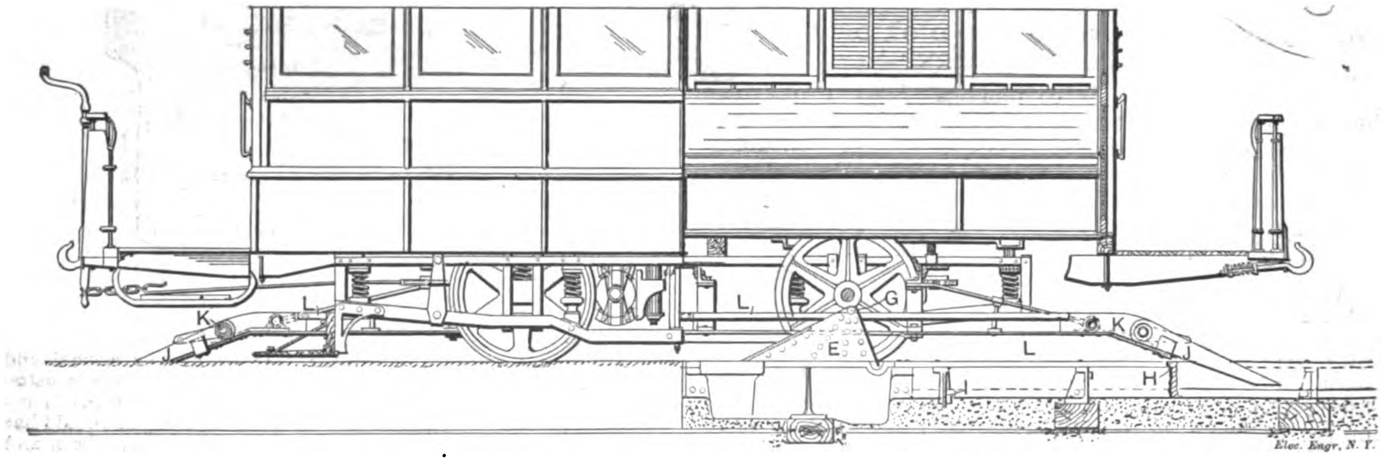


Fig. 2.—Mansfield's Electric Railway Underground Conductor System.

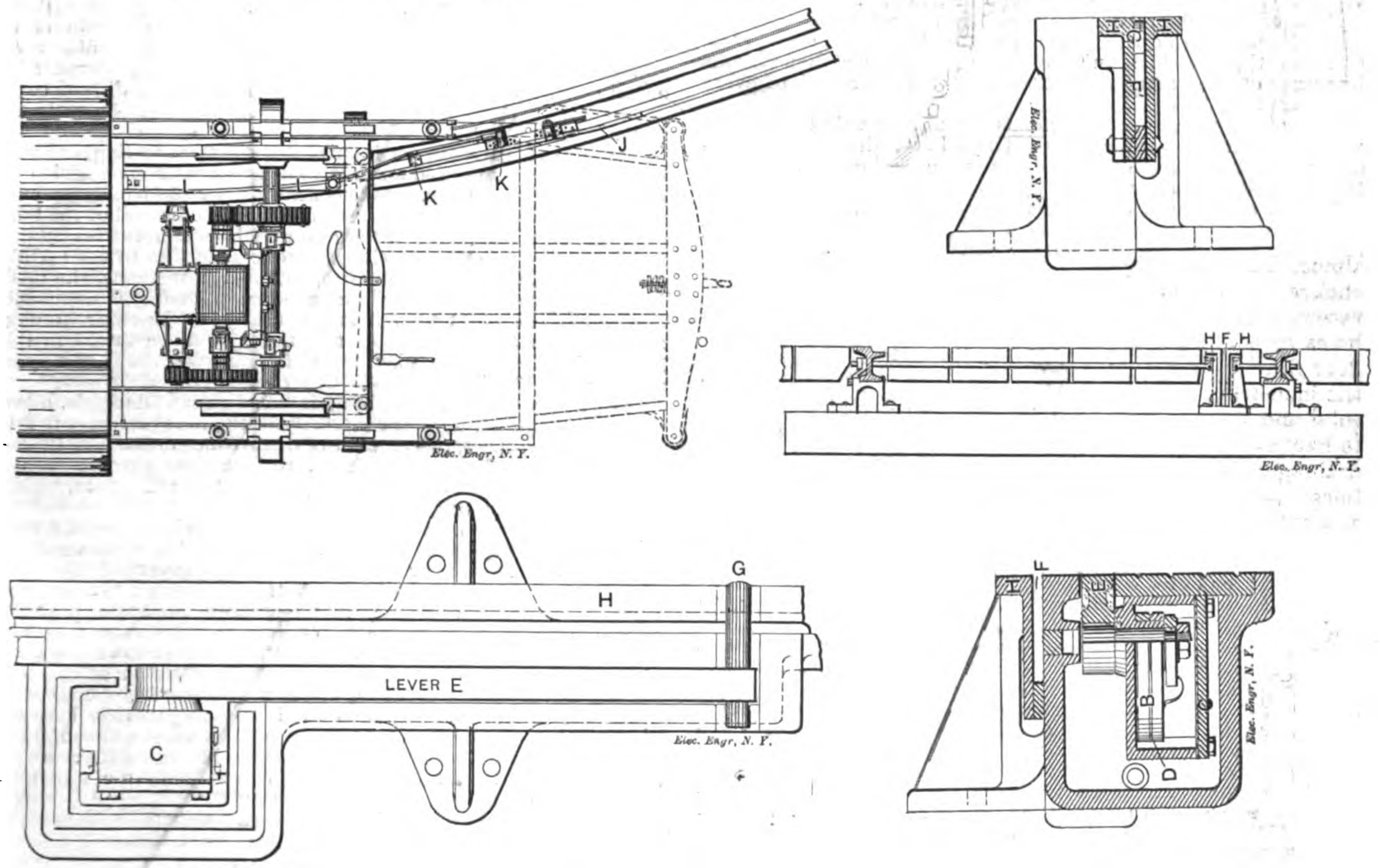
In seeking to avoid this evident drawback Mr. F. Mansfield, of this city, has designed and recently patented a system which may be said to avoid the use both of an expensive conduit and of overhead wires. The inventor has set himself the problem to secure an electric railway system that cannot be interfered with by water and shall at the same time be mechanically perfect. This has been carried out by maintaining a minimum amount of exposure of a branch conductor dead until it is elevated a considerable distance above the surface of the ground and put in electrical connection with the motor on the car. Consequently in the Mansfield system all wires are so housed that, with no cars on the line, the entire outside circuit is completely insulated. With each car run out there becomes exposed a small knob half the size of a man's thumb, and even this is not in electrical connection with the mains until raised eight inches above the surface of the ground. By this novel construction a minimum leakage is obtained. As the car passes along over the track it lifts and makes electrical connection with these knobs successively, making one before breaking with the preceding, electrical connection with the mains being open at all time except when a car is passing over the particular knob; nothing is in sight along the track but occasional boxes and a guide slot, all flush with the surface of the street.

The accompanying engravings will give a clear idea of the conduit and the method of its construction. A continuous well-insulated main conductor runs the length of the track either overhead or underground. Primary insulated branch conductors A run from the main to one pole of a switch B in a water tight box, C. These switch boxes are placed at regular intervals, about twelve feet apart along the track, having their tops flush with the surface of the street. From the other pole D of this switch box a secondary branch conductor runs along a lever E placed in position parallel with the track. The lever referred to is hinged to the switch box C and at the other end has an insulated knob G that is adapted to be raised above the surface of the street, and which projects across the top of the guide slot F. The secondary conductor connects D to this knob G and is thoroughly insulated up to that point.

The guide slot as shown is formed of two angle irons H held apart by yokes I so as to leave a slot five-eighths of an inch wide and six inches deep. This is called the guide slot. It extends the entire length of the track and its office is to guide a pick up arrangement K carried by the car under the successive lever knobs. The pick-up arrangement carried by the car consists of a slightly curved and inclined tongue J armed at the end with a wear plate. The tongue is flexible so that it can be bent laterally and is hinged to its support. It projects downwards into the guide slot.

As will be seen there is a tongue at either end of the car. The hind tongue allows of reseating the lever. Joining the plow hinges there extends a laterally flexible contact bar L insulated from the truck. It serves to support the lever along which the exposed knob rubs, making electrical connection with it and thence to the motor by means of a wire.

The operation of the system will now be readily understood. As the car moves along, the forward pick-up plow runs under the exposed knobs, on the end of the levers that extend across the guide slot in the path of the plow, elevating the same to their full height and thus closes the switch in the water tight switch box and also establishes a sliding contact with the contact bar and thence to the motor. The current returns through the motor and rails to the source of supply.



Figs. 3, 4, 5, 6 and 7.—Mansfield's Electric Railway Underground Conductor System.

The car can run in either direction at any time by merely reversing the controlling switch. By an ingenious arrangement of fusible plugs a grounded knob is cut out of circuit and by means of a forerunner connection is made with the second lever ahead and the car runs off the grounded knob. This operation is performed by the driver.

The lever and switch box being fastened together they can be jointly removed and replaced by merely taking off a cover if by chance they should get out of order.

"L'ELECTRICIEN" AND "LA REVUE INTERNATIONALE."

Beginning with the new year the above journals will be combined under the title of *L'Electricien, Revue Internationale de l'Electricité et de ses Applications.*

It is with sincere regret that we learn that the editor of our admirably conducted contemporary, *L'Electricien*, M. E. Hospitalier will not be connected with the new enterprise, on account of other more pressing duties. M. Hospitalier has long been known as one of the brightest and best of French writers on electricity, being one of the few who possess the power of easy and accurate expression. We wish our new contemporary the same success under the new regime as *L'Electricien* has enjoyed in the past.

A CASTING FOR THE BIG FERRANTI DYNAMOS.

A correspondent to *Engineering* describes the process employed in making some of the large castings for the 10,000 h. p. dynamos for the London Electric Supply Corporation: November 7, there was cast at the works of the Carron Company, the contractors for the cast iron work for the 10,000 h. p. dynamos shortly to be erected at Deptford, the first of the eight 23-ton castings which form the feet of the magnet frames, and which will eventually have to carry the whole weight of these frames, amounting to many hundred tons. As these measure some 12 ft. by 10 ft. by 6 ft. 6 in., and have each cast into their body the projecting ends of eleven magnets or blocks of soft iron 3 ft. 3 in. by 1 ft. 6 in. by 5 in. and weighing in all about 4½ tons, some idea may be formed of the nature of the casting. The greatest difficulty the contractors have had to overcome in the manufacture of these magnet frames has been the securing into the casting in a thoroughly fast and trustworthy manner of these large blocks of soft iron; this being absolutely necessary owing to the nature of the forces brought to bear on the magnets when the dynamos are at work. Possibly, owing to the very unusual nature of the casting, the same difficulty may not previously have presented itself to the founders in any case. All the ordinary methods of casting failed to secure the desired end, and very special and novel treatment indeed has had to be resorted to before a satisfactory solution of the difficulty has been found. What in ordinary circumstances would form the main core of the mould has built into its interior a light steel tank of the necessary form and dimensions to suit the magnets, and into this vessel the magnets project for about 2 ft. of their length. You have thus at once a core fulfilling all the ordinary functions of such, and at the same time in itself a water-tight vessel surrounding the magnets. After the metal has been run into the mould and allowed to set, cold water is immediately passed through the tank or vessel and caused to circulate round the magnets, but not in contact with the cast iron, for a period of from two to four days. After this time, and during which the cast iron has been kept warm as long as possible, it is found that the magnets are firmly bound into the casting and practically form a part of it. As the contractors have already cast over twenty 12½-ton castings on the same principle, only applied somewhat differently, the process may be said to have been subjected to a thorough test. The process was introduced specially for the occasion and has since been patented.

Mr. A. Irvine, representing the National Electric Manufacturing Co., Eau Claire, Wis., has sold a 1,000 light alternator to Desoto, Mo.; 500 lights to Bushnell, Ill.; 500 lights to the Home Electric Light Co., Cape Girardeau, Mo., and 500 lights to Centralia, Ill.

THE PHENOMENA OF EARTH CURRENTS.[1]

BY WILLIAM FINN.

If you place a sensitive galvanometer in any well insulated telegraph line from which the regular battery has been withdrawn and ground the opposite ends of the wire the chances are that you will find a current in the wire of sufficient strength to deflect the galvanometer needle. After repeating this experiment a number of times, you will probably conclude that the current is not a constant one, but on the contrary varies more or less in strength and sometimes in polarity also. The movements of the needle may be very sluggish at one time and play over but a few degrees of the scale, while at other times the needle may oscillate in the liveliest manner over a considerable portion of the scale on both sides of zero, showing great variations in the magnitude as well as in the direction of the current.

When you open the wire at either end these manifestations instantly cease and do not reappear until the ground connection has been again established.

It will be evident from this that the effects observed do not proceed from induction, or stray currents from neighboring wires, either of which would tend to act more strongly upon the galvanometer on opening the wire at the distant end.

The effects observed are in reality caused by currents of natural electricity flowing from place to place over the surface of the earth, and which find their way into the telegraph circuits by means of the ground connections which form a part of every telegraph line.

These currents are not sufficiently strong as a rule to interfere with the ordinary working of telegraph lines, though I shall endeavor to show later on that there are times and conditions when they cannot but impair the efficiency of working.

The investigation at various periods and by different observers into the cause of these currents has led to some very interesting and important scientific discoveries and deductions.

The apparently confused mass of data furnished by different observers on this subject, made it exceedingly difficult at first to derive any tangible results therefrom, but a careful analysis of the records has since shown that the earth current is not so erratic as might at first sight appear, but is on the contrary comparatively regular in its variations and subject to a law. Here, for instance, is a plotted record of some observations taken at Valentia upon about 300 miles of the Atlantic Cable which was lost in 1857. These early observations which extend over a period of 36 hours, were taken at short intervals apart, and the result as reproduced in the form of curves, affords a very fair idea of their regularity and periodicity.

But the most important point was the close connection observed between the variations of the earth current on the one hand, and the periods of high and low water marks on the other, as may be seen from the plotted current and tidal curves represented on the screen. In this was found a coincidence which at once suggested a clue to the possible cause of these mysterious earth currents, and the question at once arose, Were the rising and falling waters of the ocean directly responsible for their appearance, or were the same causes which created the tides to be held accountable for the earth current phenomonen also?

The tides as you know are mainly due to the influence of the moon's attraction for the waters of the globe; the relative position of the earth and moon determining the times and places of high and low water. And very much in the same way it was contended that the moon affects the distribution of the earth's electricity also, and creates electric tides or currents of electricity which flow over the earth's surface. This appeared quite plausible and agrees exactly with our knowledge of what would occur experimentally with two electrified spheres arranged to imitate the relative motions of the earth and moon.

This theory was apparently confirmed by the records obtained from subsequent observations. On the other hand this theory was so incompatible with the results of many other observations, that recourse was taken to the consideration of the next question, viz., Did the undulations of the waters of the globe, by friction or otherwise, produce those inequalities of potential at various points of the earth's surface which gave rise to the generation of electric currents?

The first consideration relative to friction was not favorably or seriously entertained, but it was thought highly probable that the moving mass of waters across the earth's magnetic lines of force might account for the phenomenon.

I have here an apparatus which will prove to you that the induction phenomena observed with a magnet holds equally good in the case of the terrestrial lines of force. The instrument is called a terrestrial induction coil, and consists essentially of a wooden ring 6 inches in diameter, upon the circumference of which has been wound an insulated wire measuring 320 ohms. This coil is made to rotate around a horizontal axis, and is placed in such a position with respect to the earth's magnetic lines of induction that the greatest number of them will pass through the space bounded by the encircling wire. This position is obtained when the plane of the coil is at right angles to the direction assumed by the dipping needle.

If I now connect the ends of the coil with a sensitive galvanometer and make the coil revolve, the convolutions of the wire will move across or "cut" the earth's lines of force, which in this instance may be likened to a shower of rain falling at an angle of 72°. The result is that induced currents are generated in the coil, which as you notice produce marked deflections on the galvanometer.

The manner in which the great tidal waves of the ocean in their movements to and fro affect this magnetic field, and how induced currents are thereby generated and circulated over the earth's surface, will now be more clearly understood. It is not at all improbable that local currents may even be developed by rivers and running streams flowing over these imaginary lines of force, and some experiments made by the writer on wires running parallel with, and at right angles to the Niagara river appear to demonstrate the correctness of this view. (Experiment shown.)

Of the two theories under discussion the latter appears to be most in accordance with the result of observations taken by the writer both here and in England. There is considerable difference in the limits of the variations and strength of the earth current in this section of the country as compared with records of the same features in England. For instance, the average strength of the British earth current is said to be about one-tenth of a milliampere while here it is certainly not less than double that amount, and very often exceeds one and two milliamperes, and occasionally rises as high as four milliamperes, with a difference of potential at opposite ends of the wire in some cases of nearly 10 volts.

My experience with earth current deflections in England was that it usually required a sensitive astatic needle upon which to take the readings. Here, on the contrary, they can be read on any wire at almost any time by inserting the 200 ohm coil of the tangent galvanometer. This difference may be accounted for by the fact that the intensity of the magnetic field due to the earth's magnetism is not alike at the two places. For instance, the total force or intensity of terrestrial magnetism in Buffalo is about 0.6 dyne, whereas in London it is but 0.4 dyne. In other words a magnetic pole of unit strength in Buffalo, would be urged in the line of dip with a mechanical force of about two-tenths of a dyne unit greater than it would be in London.

Now, since the strength of an induced current depends, other things being equal, upon the intensity of the field of force, it follows that for the same amount of disturbance created in the respective fields of the two places, the stronger current would naturally be developed in the more intense field at Buffalo, which we find to be actually the case.

But even this hypothesis failed to satisfactorily account for all the vagaries exhibited by the earth current, and as a consequence other theories, more or less plausible, were invented, the least unsatisfactory of which is perhaps the following: It is a well known fact that a difference in temperature maintained at the opposite ends of a heterogeneous conductor will cause a steady current of electricity to flow through it. Take for example a bar of copper and one of iron, and solder them together at one end, leaving their opposite ends free, and connect these free extremities with a galvanometer. If now the point of conjunction between the two bars be heated, a current will circulate through the system, and its strength will be proportional to the difference in temperature between the soldered and free ends of the conductors. (Illustration.)

Now the earth is a huge heterogeneous conductor whose opposite sides are kept at unequal temperature by the heat of the sun, and it is quite within the range of probability that thermo-electric currents are established and maintained in the earth the same as in a thermo-electric pile.

The unsteadiness of the earth current together with its variation in direction do not, however, sufficiently harmonize with this theory to make it generally acceptable, though it is interesting to note that the circulation of thermo-electric currents around the earth presents a very plausible basis upon which to account for the magnetic condition of the earth, and in that way these thermo currents may be the indirect means of producing the effects observed.

But, from whatever source these currents of natural electricity flow, they are always to be found in the ground and ready to be tapped, and the question arises: Can they in any way be harnessed and utilized in the service of man as is now the case with the flow of natural gas? The currents are certainly far too weak and unreliable to be of any practical advantage in telegraphy with the style of apparatus at present employed, but, as I stated at the outset, I believe they are sufficiently powerful at times to interfere with the regular working of that service. This opinion is based upon the result of numerous tests made of the value of working currents on certain telegraph lines passing through Buffalo. For instance, the actual value of some of the signaling currents taken on certain polar duplex circuits as well as on the polar sides of quadruplex systems, varies from eleven to thirteen milliamperes, which is not enough current even under favorable circumstances to satisfactorily operate these systems, and for which, as a rule, a great deal more current is allowed. But the appearance of an opposing earth current in the wire under such conditions would aggravate the case by an amount proportional to its strength, and might not only destroy the uniformity of signals, but render them altogether unintelligible,

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[1] Abstract of a paper read before the Buffalo Electrical Society, Jan. 5, 1891.

I have taken readings from a distant battery whose reversals of polarity have indicated a difference in strength of from one to four milliamperes, when neither the state of the wire nor condition of the apparatus appeared to warrant any such variation. On these occasions the wires have nearly always given evidence of strong disturbing forces emanating from the ground. Their influence can of course be counteracted by increasing the working strength of the battery, or by substituting wires of smaller resistance, either of which would increase the margin of the battery current beyond the variable limits of the earth current.

There are certain characteristics connected with earth current variations, which make the study of that phenomenon not only exceedingly interesting, considered from a purely scientific standpoint, but which are also regarded as possessing features calculated to render them of considerable commercial importance. It has been shown by certain investigators that when uninfluenced by outside interference these currents ebb and flow over the surface of the globe like the tides of the ocean; and that the variations observed on any given wire afford a sort of index to the variations which may be looked for on other wires.

The curve demonstrations not only show its wave-like character, but also clearly define the course of the path taken by the current, which, in the case under consideration, was from a point N. E. to S. W. and happens to represent the prevailing direction of these currents in England.

One other significant fact noted during this particular series of observations was this: There were readings obtained from several other wires at the same time as the above, which did not harmonize either in strength or direction with those already given.

A study, however, of the plotted curves made by these irregular currents, in conjunction with those mapped out by the more regular ones, plainly shows that the discrepancy in the agreement of the results is the outcome of some local disturbing force, the area over which it manifests itself being clearly discernible, as is also the length of time during which the disturbance lasted.

It will be evident from this, then, that the study of the comparative results upon a number of wires around a given point, may lead to most interesting and instructive features having an important bearing, perhaps, on some of those natural phenomena affecting the condition of the globe or of certain localities upon its surface. For example: The disturbance noted in the London records may have been occasioned by some convulsion more or less violent, or other internal forces at work below the earth's surface, due either to local strain—such as upheaval or contraction—or brought about by chemical changes, a knowledge of which might be of the utmost importance. In certain volcanic regions the discovery and study of these internal forces are materially assisted by means of telephonic and recording apparatus attached to buried wires, which instantly convey the intelligence of any unusual commotion happening beneath.

During the course of several months' observations on various wires radiating from Buffalo, I have had many opportunities of noting exceptional fluctuations in the intensity and polarity of earth currents in this vicinity and though I have been unable in the majority of cases to connect these with anything of a definite character, there have been times when the appearance of earth current disturbances has coincided with the occurrence of unusual solar or meteorological phenomena, which fact would appear to establish a close identity between them.

From the result of other observations made here, I am quite convinced that there remains little room for doubt as to the truth of the general law affecting the distribution and direction of the normal earth current.

I have selected from a number of such observations those recorded on wires extending to Toronto, Chicago, Cleveland, Pittsburgh, New York and Albany, on December 14th, which will more clearly demonstrate this point.

The directive force curves show the definite direction taken by the current. This direction is from Cleveland—which shows the most strongly positive reading—to New York, the most strongly negative point. The line of least intensity is that between Toronto and Pittsburgh, or nearly north and south, which may be roughly considered as a direction at right angles to the easterly and westerly course of maximum current.

The telegraph wires of this country are too much occupied, as a rule, to admit of long and systematic records being made upon them, and hence it is somewhat difficult to ascertain with any degree of certainty the prevailing direction of earth currents in the United States, but from the evidence collected here the maximum intensity, in this section at least, appears to extend from a point, N. W. to S. E. The daily records taken on wires between New York and Chicago, show an almost invariable flow of the current from west to east, and it is on such wires as a rule that the maximum effects are obtained.

It occasionally happens that a wire grounded at some terminal office will exhibit totally opposite results as compared with those derived from intermediate points on the same wire. Thus, for example, on a wire grounded at Cleveland on Oct. 1, the earth current deflection was of an electro-positive character; that is to say, one whose polarity indicated that the direction traversed by the current was from Cleveland to Buffalo; but upon having the wire cut and grounded at Erie and Dunkirk, respectively, these two sections of the wire presented an electro-negative appearance of about the same strength as the Cleveland current, and this anomaly in the wire existed for nearly five hours, after which the direction of the current coincided in all three cases.

It thus appears that for some reason or other during the period named, Buffalo was at a lower electric potential relatively to Cleveland, but at a higher potential with respect to the intermediate points, though all these points may be considered as being in the same geographical straight line, and this singular result has appeared on subsequent occasions over the same route, as also on lines extending in other directions.

It is, however, during the periods of maximum sun spots that the more violent fluctuations in the earth currents are felt. The effects observed on the wires at such times are of an entirely different character from those we have been discussing, and are usually classified in the category of magnetic or electric storm current effects. These electrical hurricanes come and go without any warning, and while they last are extremely irregular in direction, and of such enormous magnitude as to almost invariably upset the working apparatus. They also exert a direct influence upon delicately suspended magnetic needles without the aid of any conducting wire. The direction in which they flow is usually a straight line from one ground connection to the other, and not by the actual course taken by the wires, and they sometimes attain a current strength of 30 or 40 milliamperes which is more than is necessary to operate our duplex circuits, and almost powerful enough to maintain quadruplex working.

It is customary in the British telegraph service for the wire chiefs to note particularly the period and extent of these abnormal earth currents at all points where observations can be made without interfering with the regular service; and the data thus obtained is forwarded to London, where it is analyzed, plotted out when necessary, and the result made public before some of the scientific societies.

There are many difficulties in the way of securing records of this description in America owing principally to the "closed circuit" system in vogue here; but it would be possible on such occasions to take note at least of the circuits that are not affected by the disturbing forces, for the direction of such circuits would mark the course of the equipotential lines, which are always at right angles to the path taken by the disturbing elements. Mr. Preece, the well known English government electrician, who has made the subject of earth currents a favorite study for years past, has always entertained the idea that they are directly due to the action of the sun, which by induction brings about a variation in the distribution of the lines of potential on the earth's surface. It appears quite certain that there is a close relationship between the condition of the sun spot period on the one hand, and these great temporary electric storms on the other and all information obtained as the result of accurate and systematic observations on telegraph wires at times of unusual solar excitement cannot but help to bring about important additions to our knowledge of the physical condition of the earth.

RUMORS OF TELEPHONE WAR.

With regard to the extension of the long distance telephone system, and the visit of Mr. A. S. Hibbard to Cleveland, Mr. J. P. McKinstry, of that city, is quoted by the local *Plain Dealer* of December 21, as follows: "It is possible," said Mr. McKinstry, "that the Western Union Telegraph Company may enter into a competition with the Bell Telephone Company in the enterprise now under process of construction. There is quite a story, by the way, relative to an old fight between the Western Union and the Bell telephone people. During the year 1879–80 a contest developed between these two companies. It seems that at Ft. Wayne the telegraph company put telephones in different parts of the city. They furnished a free carrier service to certain parts of the city and gave the public a very excellent service. Everything moved along all right until the Bell company became strong competitors. The result was that the fight between the companies waxed warmer and warmer until a final compromise was effected. By the terms of this compromise the telegraph company sold out their telephone property to their rivals. There was some serious hitch in the transaction and as a final result suit was brought. The suit is pending, I think, at the present time, and the construction of the new telephone line may bring about a renewal of the old difficulties."

Mr. J. M. Denniston, of the Westinghouse Co., has just closed a contract with the Pabst Brewery Co. of Milwaukee, for a 1500 light direct current plant of the U. S. system.

THE DETERMINATION OF THE WORK DONE UPON THE CORES OF IRON IN ELECTRICAL APPARATUS SUBJECT TO ALTERNATING CURRENTS.[1]

BY T. H. BLAKESLEY.

When the case is one of a transformer, the problem may be solved by the employment of three dynamometers in the way I have already pointed out; but in that of an electro-magnet, where we have only one coil to deal with, the problem still admits of solution if we further employ a condenser of determined capacity, and possess a knowledge of the period by means of some speed indicator. The plan is as follows:—

Arrangement.—Having the machine and magnet in series, insert the three dynamometers in series immediately at one terminal of the electro-magnet, placing one pole of the condenser to the other terminal, and the second pole to that point of the middle dynamometer where its two coils join.

Observations.—Obtain good simultaneous readings of the three dynamometers, and, if necessary, of the speed indicator.

Elements of Calculation.—Let a_1, a_2, a_3, be the angles read upon the instrument (1) in the generating section, (2) in the electro-magnet section, (3) which has its coils divided.

Let the reducing formula for the three instruments be respectively,

$$\begin{aligned}(\text{Current})^2 &= k_1\,\theta,\\ \text{“} \quad &= k_2\,\theta,\\ \text{“} \quad &= k_3\,\theta.\end{aligned}$$

Let C be the capacity of the condenser.
R " resistance of the electro-magnet.
T " semi-period.

Then the entire power at work beyond the terminals, *i. e.*, the heating of the wire, the heating of the core by induced currents, and the heating of the core due to hysteresis, is expressed by the simple formula—

$$\frac{T}{\pi C}\sqrt{k_1\,k_2\,a_1\,a_2 - k_3^2\,a_3^2}.$$

The expression itself is independent of the resistance, but if we desire to know the power heating the core, we must deduct from the above the power heating the wire, viz.:—

$$k_2\,a_2\,R.$$

The difference between these two quantities also happens to be proportional to the tangent of the magnetic lag, another proof of the universal concurrency of lag and loss of power.

THE RETURN ELECTRIC RAILWAYS MAKE FOR THEIR FRANCHISES.[2]

BY W. B. FERGUSON.

As there has been considerable discussion through the newspapers relative to cities and towns throughout the commonwealth giving franchises to street railway companies without being compensated in any way, I think it is time for the representatives of the street railway companies to be heard in the matter and state their side of the question. The articles which have come to my notice set forth, among other things: That the franchises are procured without remuneration to the public; that the streets are given up to the monopoly of the street railways without the towns and cities being reimbursed therefor; and in the case of the electric roads, that the danger to life is great; that the profits of the street railway companies are enormous.

In answer to the first statement, I would say that almost every road that has been opened to the public by the street railway companies, has enabled the public to ride from 50 to 100 per cent. cheaper than they could ride on any other public conveyance. As in the case of the proposed extension of the tracks of the Merrimack Valley Horse Railroad to South Andover. The present fare on the steam road is 10 cents between South Andover and Lawrence; it is the intention of the street railway company to charge but 5 cents, and on through cars to Methuen, the same fare will be charged, 5 cents, as at present between Methuen and North Andover. I note this particular case because it comes under the observation of the people of Lawrence and vicinity.

As to the second statement—that street railway companies occupy the streets of towns and cities without due compensation being given therefor, will say that it is a well known fact that it is a law of the State, that the street railway companies shall construct their tracks in a manner satisfactory to the officers of such municipalities and that they shall ever maintain to their satisfaction the space between the rails and 18 inches outside of each rail, thereby relieving the city or town of the expense of keeping that portion of the street in repair, which will usually average from ⅓ to ½ of the entire street; and that they shall so construct their tracks that carriages and vehicles of any kind can pass over them in safety.

One of the benefits that cities and towns receive from the street railway is the increased valuation of real estate along the line of the route.

In the case of electric roads, the towns and cities throughout the State are demanding much more expensive poles than they ever exacted from the electric light, telegraph or telephone companies, and the street railway companies have always been willing to meet the demands of the public in this direction. As to the wires that are necessary, in the construction of an electric road, there is not a single instance where a human being has been killed by the current used in the operation of electric cars; while we all know that the electric light companies are obliged to use a deadly current in order to give a satisfactory service.

Regarding the last statement, as to profits that the street railway companies receive, I would say that the public have a wrong idea, as a rule, as to the profits that are derived from street car traffic. According to the last annual report made by the board of railroad commissioners, the dividends from the street railways throughout Massachusetts averaged less than five per cent, on the money invested.

In conclusion, I would say that if too many restrictions are placed upon the street railway companies, and too many requiremants exacted of them, they will necessarily be unable to give the public the cheap transportation and efficient service that they now furnish.

SOME OF THE TERMS OF THE HATHERLY, MASS., RAILROAD FRANCHISE.

As great interest is taken in electric railway franchises, we append, as an example, some of the more important provisions in the franchise just granted to the Hatherly Street Railway Co., by the selectmen of Whitman, Mass.:—

"The right to lay down the tracks located by this order is upon condition that the said company shall well and truly comply with all the laws of this Commonwealth applicable thereto, also with all the requirements of this order and such further regulations as the Board of Selectmen may from time to time, adopt. Upon condition also that the said company shall give a bond with sufficient sureties to the approval of said Board in the penal sum of ten thousand dollars to comply with the said laws, regulations and requirements and to indemnify the town for all losses, injuries, expenses, suits and actions arising from any carelessness or neglect of themselves or of their employés, or from, or on account of the existence of said tracks. Said tracks shall be laid in conformity with the existing or established grades of said streets and in case the grade of any part of said streets shall be changed by the proper authority, the expense of taking up and relaying said tracks shall be borne by said railway company. In case a change in the grade of said streets or any portion thereof shall be judged necessary by the road commissioners and selectmen for the proper laying of said tracks, the expense of making such change of grade shall be borne by said company including all damages paid abuttors by the town on account of damages, from any such change of grade.

"Where the tracks are laid on one side of the street, there shall not be less than eighteen feet width of space safe and available for carriage travel between said tracks and the opposite curb line of said highway, and whenever any widening of the road bed shall be necessary to comply with this requirement the whole expense of such widenings, including land damages, shall be borne by said company.

"The kind of rail used shall be the Johnson girder rail, weighing not less than forty-five pounds to the yard in conformity with the plan. The remainder of the distance, the same kind or the T rail of the same weight may be used. All rails shall be laid on steel chairs or four by six inch timbers, all such chairs and all timbers under either kind of rails, shall be laid on chestnut or oak ties not exceeding six feet apart between centres, said rails have fish plates at their joints. From West street to the north corner of Vernon street and from Temple street to the west corner of Harvard street, also wherever said tracks cross a street, said tracks shall be paved eighteen inches on the outside and twelve inches on the inside of the rails, the remaining space between the rails to be filled in with crushed stone.

"The paving stones used shall be of the first class subject to the approval of the Road Commissioners. The whole work of laying down said tracks shall be to the satisfaction of the Road Commissioners and approved by the selectmen. All streets shall be left by said company in as good and safe condition as the same may be when the laying of said tracks is commenced to the satisfaction of the Road Commissioners. In case said company shall neglect or refuse to keep its tracks safe and convenient for travelers within the requirements of the statutes necessary and reasonable repairs may be made therein by the town under the direction of the Road Commissioners and Selectmen and the cost thereof, shall be borne by said company.

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[1] *Nature.*

[2] Open letter of the president of the Merrimack Valley Street Railway Co.

"When there shall occur a fall of snow sufficient to allow the use of conveyances on runners on said streets, no snow plough shall be used on said tracks nor shall said company cause or allow snow to be removed therefrom, nor use or allow to be used any salt or other substance or substances for the purpose of melting snow on said tracks, unless written permission be obtained of the road commissioners.

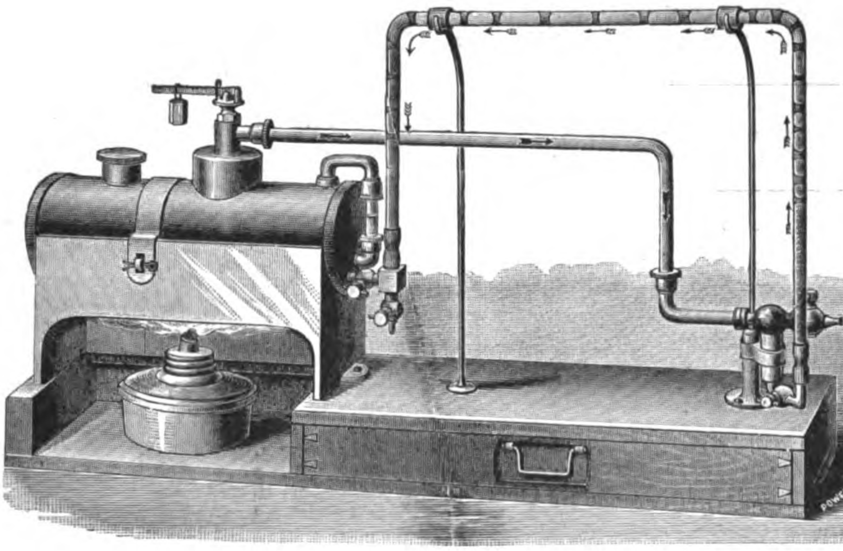
"Said company shall have the right to erect poles and structures for the purpose of operating their road by electricity. Said poles may be sawed square, or round at the option of said company, but whatever kind is used, they shall be straight and well dressed, subject to the approval of the selectmen.

"In all cases where said tracks are laid on one side of a street there shall be not less than three and one-half feet from the curb line of the sidewalk to the rail."

THE STEAM LOOP.

A LONG-STANDING synonym for impossibility has been the inherent inability of water to "run up hill;" but that it can be made to do so without the aid of pumps, traps or any form of mechanism, is demonstrated by the steam loop, a working model of which is illustrated herewith.

The purpose of this loop is to return the water of condensation from a steam system to the boiler from a point either above or below the water level. In the model, illustrated in the accompanying engraving, for which we are indebted to our excellent contemporary *Power*, such a system is represented by the pipe leading from the steam dome of the boiler and discharging through the valve at the right. This, for example, might be the main steam pipe connecting an engine with the boiler. Just before being discharged in the model, the steam passes through a separator which enables the suction or "steam sweep" of the loop to collect the water which has been carried over with the steam or resulted from condensation. The loop commences with the riser at the right. The pipe forming this riser is, at proper height, turned toward the boiler with a slight inclination, and at the boiler again turned to form a drop leg communicating with the interior below the water line.



THE STEAM LOOP.

In order that steam may flow from one point to another a preponderance of pressure is required at the starting point sufficient to overcome the frictional resistance to its movement. It follows then, that at any point on a circuit of moving steam the pressure will be less than that in the boiler by an amount increasing with the distance from the boiler, measured by the flow and the velocity of the movement.

As the riser is placed at the end of the system and the pressure is further reduced by the resistance of the loop itself, it follows that the point of lowest pressure will be in the drop leg. Were the pressure uniform throughout the system the water would stand in this leg at the same level as in the boiler; but, having a lesser pressure above than below, when the stop valve between the boiler and drop leg is opened the greater pressure in the boiler forces the water in the leg upward until the height of the column balances the difference in pressure. The top of this column forms a "dead end" at the point of lowest pressure, and toward it the circulation naturally sets, carrying with it the water of condensation, at first in the form of a spray or a thin film swept along the inner surface of the pipe, and afterwards, when the accumulation of water is sufficient, in the form of small slugs or pistons of water, which completely fill the pipe at intervals, traveling rapidly toward the dead end. This action is very plainly shown in the glass tubes of the model. As each slug is deposited on top of the column in the drop leg it increases the weight of the column above that due to the difference in pressure at the top and bottom, and sufficient water enters the boiler by gravity to maintain the equilibrium.

The arrangement is thus equivalent to a gravity return, the water reaching the boiler continuously and rapidly and at a temperature very nearly that of the boiler itself. Its application to an engine results in removing the cylinder from the dead-end of the system to the middle of an active circulation, overcoming the tendency of water to accumulate at that point and returning to the boiler what would otherwise not only be wasted in the exhaust but would be also a potent cause of trouble and danger to the engine. Its application to radiators, jackets, steam vats and other forms of apparatus where steam is used for heating not only furnishes a simple method of returning the consequent condensation, but results in an active circulation which much increases the efficiency of the heat-using appliance. It is being applied by Westinghouse, Church, Kerr & Co., 17 Cortlandt street, New York.

EXPERIMENT WITH A CONDENSER.

Writing to the *Electrician*, Sir William Thomson says: "On the day after our last meeting of the Physical Society I saw at Deptford, in a test by Mr. Ferranti of a vulcanite tray subjected to 20,000 volts (square root of mean square), a most interesting illustration of one of the subjects discussed in connection with Mr. Swinburne's paper. The tray was rectangular, with rounded corners and edges, and may have been 8 inches or 10 inches long, by 5 inches or 6 inches broad. and 1½ inches deep (I write from memory). The vertical sides ended in a flat lip, about 1 inch broad, projecting horizontally on all sides. It was laid on the bottom of a large metal tray filled with water, and was filled up inside to a depth of about half an inch. During the test we observed a blue line of light all round the water line, both inside and outside, which seemed to be everywhere about a quarter of an inch broad (we did not apply a ruler or compasses to measure it). When the test was completed and the electrification stopped, we took the tray out and looked at it carefully all round. We found, as we expected, that there was no sign of perforation, but we saw a very remarkable appearance all along the lines, inside and outside, which had been the boundaries of the water. They showed, at regular intervals, little vertical marks; the explanation of which was, no doubt, capillary standing waves produced in the water by the electric force, and analagous in hydro-kinetic and capillary quality to the ripples seen inside a finger-glass caused to sound by a wetted finger drawn along its rim. The blue light which we saw was, of course, due to the same cause as the well-known sparkling at the edges of the coatings of a Leyden jar when suddenly charged or discharged. The sparkling described by Mr. Swinburne in his mica condenser was no doubt due to the same cause. When the breadth of a band of sparking round the edge of a metallic coating is considerable in comparison with the linear dimensions of the coating in any condenser subjected to rapidly alternating high potential, there must be considerable heating due to it; and the mere fact of heating would not prove that any sensible proportion of the heating is due to viscosity of electrostatic inductive capacity.

"An internal sparkling or quasi-sparkling in some of the ingredients of heterogeneous insulators may be the cause of some of the heating of condensers which has been observed by Mr. Swinburne and others.

"Recurring to the subject of duration of contact between two mutually impinging metal balls, we must not assume that this is the duration of electric conductance between them. On the contrary, when the potential of the charge is several thousand volts, there might be separation to the extent of a millimetre or two without cessation of very effective electric conductance. But it will be interesting to find whether, with charges of one or two volts, the exceeding shortness of the duration of metallic contact of mutually impinging balls can suffice to let us sometimes find the electrification of a condenser reversed, after a discharge by impact, even in cases in which the period of the oscillatory discharge with constant resistance is only a few ten-thousandths of a second."

JOY IN CUMMINSVILLE.

An amusing instance of the enthusiasm with which electric railroads are greeted all over the country is furnished by the following item from the Cincinnati *Times-Star:* "The citizens of the Twenty-fourth and Twenty-fifth wards will all unite Saturday night to celebrate the completion of the circuit around Cumminsville of the Colerain avenue electric railroad. They will meet at the intersection of the Colerain and Spring Grove avenues at half-past 7 o'clock sharp. All who may wish to make the trip downtown over the entire route will be amply accommodated, as a sufficient number of cars will be provided by the company to carry all comers. A band of music will head the train and the gentlemen will all bring their horns and the ladies their bells to make the event memorable. This route will bring the citizens of Cumminsville within 25 minutes of the post-office, and its completion opens up a new era for the large and available territory of that suburb."

European Correspondence.

LONDON.

Lighting in Venice.—Village Lighting Plants in Europe.—Russian Telegraph Work.—Accident to Mr. Drake.—Chamberlain and the Chelsea Co.

An alternating current station which was erected at Venice by a Milan company some time ago, has so great a demand upon it for light that it is deemed necessary to still further increase the power. A fourth machine for 80,000 watts will be placed in position. This addition will raise the capacity of the station to 320,000 watts. A short distance from this station the same company is erecting a private installation for a local manufacturer. A large water power is to be utilized, and it is intended to supply electric light and motive power to the establishments in the valley. This installation presents interesting features, since the alternating current will be used both for lighting and power.

The rapidity with which small villages on the European continent take up electric lighting is well illustrated by one or two examples to hand. Such minor Italian villages as Nicastro and Villagio Bella have resolved on the introduction of electric light to be supplied from a single central station erected at Nicastro. For the public lighting in the latter village it is proposed to erect 150 glow lamps of 16 c.p., 40 of 25 c.p. and 10 of 100 c.p., and three arc lamps. Bella is content with 20 glow lamps for its streets.

The distance between the central station of Nicastro and the village is 1300 metres.

Another instance of enterprise on a small scale is Callais, near Nimes, where 465 people dwell, and the streets are lighted by 25 lamps. The motive power is derived from a small waterfall. Besides lighting the village, the current is employed during the day in putting into motion pumps for supplying the neighborhood with water.

The Russian Telegraph Service is contemplating the construction of a telegraph line along the shores of the White Sea to the Norwegian frontier. The present means of communication is a bi-weekly postal service.

Mr. Drake, of the firm Drake & Gorham, of London, has met with a serious accident While superintending the electric lighting work at the New Scotland Yard, he fell into an area fifteen feet deep, and broke his thigh.

The temporary failure of the supply of electricity from the Grosvenor Gallery station is producing effects which will not bear favorably on the electric lighting companies here. Long letters have been sent to the *Times*, complaining about the supply of current by the London Electric Supply Corporation, and this gives Mr. R. Chamberlain an opportunity to attack the Chelsea company. This gentleman asked in the House of Commons a few nights ago, whether the attention of the Board of Trade had been called "to a long continued default of the Chelsea Electric Supply Company to furnish the statutory current of 100 volts, and to the serious loss of illuminating power sustained by consumers in consequence." In his letter he complains that the pressure drops to 98 volts, thereby leaving the place in semi-darkness. On the other hand, the company state that 100 volts is constantly maintained and Mr. Chamberlain is the only customer who complains. They further cite with justice, the fact that the Board of Trade allow a variation of four per cent. above and below 100 volts. One can see at once that the complaints are not well based and that Mr. Chamberlain endeavors to stretch a point when he says that two per cent. variation causes semi-darkness. Unfortunately, the public may follow the error and conclude all is not well with electric lighting.

London, Dec. 20, 1890.

"A Palace of Light.—The Chelsea Electricity Supply Company.—Swansea Lighting.—Electricity and the Census.—Post Office Lighting.—City and South London Railway.

What is well named a "Palace of Light" is the Hofburg of Vienna—the residence of the Emperor of the Austrians—which for the past two or three nights has been one blaze of light. The electric light has been completely installed throughout the place. Incandescent lamps are wholly used. The chief difficulty experienced in fixing these was on account of the strict orders against any alteration of the character and outward appearance of the handsome candelabra in embossed gold which date from the time of Francis I. In the great hall there are twenty-seven of these with fifty-four lights apiece. The difficulty in mounting the fittings was surmounted by inserting small white lacquered wooden tubes, resembling candles at a distance, into the old lustres, each tube being fitted with a movable lamp. The entire installation when completed will consist of 5,250 lamps and nearly 1,800 lights in the entrance halls, galleries, etc. This will no doubt be about the largest installation in any one building in the whole of civilized Europe. The length of wires is said to be fifteen miles. The results of the experimental lighting are said to have filled the spectators with enthusiasm for this mode of lighting. Magnificent ceilings were seen as they had never been seen before and a wealth of color was developed in the famous Flemish tapestries on the walls of the privy council chamber the existence of which had never been suspected.

As the various systems employed by the London companies are subjected day by day to further tests one becomes acquainted with some of the failures in cases of emergency. We referred last week to complaints in the *Daily Press* against the Chelsea Electric Lighting Co. Further information to hand makes one prone to think that something must be out of gear. As your readers may know, this company uses the direct current with accumulators charged at high pressure and discharged direct at low pressure on the mains. A notice has been issued by the company which states that it is the intention to discontinue the supply of electricity between the hours of midnight and four o'clock in the afternoon. This is a measure rendered necessary owing to the continuance of the fog. Naturally enough consumers feel very bitter at being deprived of light when all around is darkened by the fog, and this feeling extends to the vestry controlling the district. At the last meeting of this body a resolution was passed which will injure the reputation of the concern far more than letters in the *Times*. It was to the effect that until this company could supply light night and day, permission would not be granted to extend the area of supply.

Mr. Preece, who occupies the responsible position of technical adviser to many local bodies, has recommended the Swansea Town Council to adopt the tender of Messrs. Crompton for the erection of arc lamps of 2,000 c. p. in the streets at a cost of £23 per lamp per annum.

The Austrian Government is resolved to follow the example set by America in utilizing electrical counters at the next census.

Electric lighting in Postoffice work is gradually growing in favor. Newcastle offices already lighted and the Bristol post-office will soon be supplied in the same way.

Up to date the working of the City and South London underground line has been most satisfactory, the only difficulty being that of carrying the number of passengers desirous of traveling by it. Thirty thousand people traveled by the line on the opening day and since then the rush has at times been so great that the booking of passengers has had to be stopped till the platforms were cleared of those who were waiting. The working has consequently been strained to the utmost and trains have sometimes left with as many standing as sitting passengers; nevertheless there has been but one hitch due to electrical cause and that was merely the slipping out of a connection. As a precautionary measure, however, the traffic is stopped early—at about half-past ten—and all the day on Sundays in order to give time for a thorough examination and inspection of everything.

H. S.

London, Dec. 24, 1890.

Society and Club Notes.

MR. F. L. POPE TO LECTURE BEFORE THE ELECTRIC CLUB.

The next regular meeting of the Electric Club will be held Jan. 22. Mr. F. L. Pope will deliver a lecture entitled "Some Notes on the Electric Railway, Historical, Statistical and Technical." The subject is one of which Mr. Pope has long made a special study. He will handle it in a broadly popular manner so as to make his points clear to the large gathering that may be expected of those who will hasten to enjoy the Club's hospitality that night, and who have hitherto been looking for just such an exposition of the subject.

MASSACHUSETTS ELECTRICAL ENGINEERS AND MECHANICS ASSOCIATION.

At the meeting of the Massachusetts Electrical Engineers and Mechanics' Association, Boston, last week, the following named officers were installed: Past president, John Dean, Jr.; president, James E. Cole; vice-president, Eugene C. McCarthy; treasurer, Charles Toner; financial secretary, George W. Newman; recording secretary, James E. Lynch; corresponding secretary, W. C. Woodward. The committees on the ball to be held in Odd Fellows' Hall the 29th inst. made favorable reports, and it was voted on that occasion to make the finest display of electric lights and lighting that Boston has yet witnessed.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 53rd meeting will be held at eight o'clock, on Tuesday evening, January 20th, at the rooms of the Institute, No. 12 West 31st street, near Fifth avenue. The session will be devoted to the discussion of the following subjects: Inductance and Its Proposed Unit, the "Henry." This discussion of Mr. Kennelly's paper, postponed from the last meeting, will be opened by Dr. Cary T. Hutchinson. The paper will be found printed in full, and revised by the author, in THE ELECTRICAL ENGINEER, Dec. 24th. Reports of the following Committees will also come up for action: The Standard Wiring Table Committee; Committee on the Value of the "Henry"; Committee on Amendment of the Patent Law. Copies of the reports of the first two Committees will be furnished upon application to the secretary.

Non-resident members who are interested in the above subjects are invited to contribute their views in writing. Gentlemen not identified with the Institute are cordially invited to attend.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

All parties desirious of exhibiting in the hall secured by the National Electric Light Association at Providence, R. I., on the 17th, 18th and 19th of February next, must send in their application at once, as the allotment of space will soon begin. The applications already sent in aggregate nearly all the available space in the hall, and it may be necessary to cut down the applications pro rata.

Appointments, Etc.

APPOINTMENTS, &c.

MR. JOHN H. SHARPE, of the Edison Illuminating Co., in Brooklyn, has been appointed general superintendent of the Nyack Electric Co., Nyack, N. Y.

MR. H. W. BLAKE, late of the Intelligence Department of the Sprague and Edison General Companies, has become assistant editor of the *Street Railway Journal*, with special charge of the electrical department.

MR. A. CHURCHWARD, late of the Crocker-Wheeler Motor Co., has been appointed assistant electrician of the Riker Electric Motor Co., of Brooklyn.

MR. JOHN D. EASTERLIN, under the re-arrangement of the districts of the Southern Bell Telephone Co., has been appointed superintendent of the consolidated second and third divisions, with headquarters at Atlanta, with charge of the united repair shops there.

Mr. JOHN CASSIDY, who has long been in charge of the telephone service of the Sandwich Islands, has been appointed by the government to the supervision of the electric light circuits, etc.

LIEUT. JAMES A. SWIFT, Signal Corps, now on duty at Titusville, Fla., will make a thorough inspection of the Signal Service stations in Florida.

Patent Notes.

EFFECT OF DULL TIMES ON INVENTORS.

As the Inventors' Record in THE ELECTRICAL ENGINEER shows, the number of electrical patents issuing is remarkably well maintained, and the recent financial stringency would seem to have had little effect in electrical fields of invention. But as to the situation, a special dispatch from Washington, of Jan. 8, to the *Evening Post*, says:—"The 'hard times' produced by the McKinley Tariff Act and the backing and filling of the Republican financiers in Congress have told upon even the Patent Office—a quarter where one would scarcely look for a barometer of public feeling in pecuniary matters. The law gives inventors six months, after notice of allowance of their claims, for the payment of the final fee and the issue of their patents. The final fee is $20—a sum which, in the cases of a large number of ill-paid mechanical geniuses, is not so easy to scrape together. So many budding patentees have found the money stress too great for them that the weekly issue has sunk from an average of about 500 letters to something more than 300, and the income of the office from fees is estimated to have fallen off at least 25 per cent. Leading patent attorneys in this city are complaining that business was never so dull before, and that they are hardly making enough to keep their offices running. As times grow easier, doubtless the figures will spring back again. Meanwhile, his enforced leisure, comparatively speaking, will enable the Commissioner to give to the necessary improvements in his office a part of the thought which has hitherto been almost monopolized by the survey of work accomplished. The office is in very bad condition—overcrowded, and ill supplied with facilities. A strenuous effort on the commissioner's part to force upon Congress the recognition of his most pressing needs would perhaps be more fruitful of future good to the service than his ambition to show what wonders can be accomplished with the meagre resources now at his command."

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of January 10, 1891, from New York, Boston and Washington; Pittsburgh, January 9.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	79⅜	Edison Gen. Elec. Co.	88
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Centl. & So. Amer.	*145	Consol'd Elec. Lt. Co.	...
Mexican	*210	Edison Illn'g Co. N. Y.	70
Com. Cable Co.	104	U. S. Elec. Lt. Co.	80
Postal Tel. Cable	39	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	44¼	Ft. Wayne Co.	10⅝
" Pref'd.	....	Am. Bell	213
" Series C.	....	Erie	49½
" " D.	5¾	New England	51
" Int. Co.	....	Mexican	.75 cts
Thomson Welding Co.	....	Trop. American	..
Thomson Eu. Welding	....	Edison Phon'gph Doll.	1

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	140
Ches. & Pot. Telephone	67	Eck.&Sold. Home Elec. Ry.	56
Amer. Graphophone	*11¼	Georgetown & Tenallytown	49⅛

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co.	8¾

* Ex Dividend.

WASHINGTON, D. C.—The Board of Electrical Control of the District of Columbia, created by Act of Congress, has organized. It consists of Prof. H. A. Rowland, of Johns Hopkins, Lieut. F. R. Shunk, of the U. S. Engineers, and Mr. A. Rosewater, of the *Omaha Bee*, an old telegrapher.

ELECTRIC RAILROADING IN AUSTRIA.—It is said that an electric road is to be built from Vienna to Buda Pest, a distance of 250 kilometers. The journey now occupies 4½ hours, and it is proposed to do it in 2½. The statement lacks confirmation.

Reports of Companies.

LAREDO IMPROVEMENT CO.

A special dispatch of January 7, from Lawrence, Kan., says: Chas. F. Yeager and B. F. Nicholson were yesterday appointed receivers of the Laredo Improvement Company. Mr. Moore, of Lutcher & Moore, of San Antonio, president of the company, says the assets are $395,000, the actual cost of the real estate and improvements and their electric street-car railroad. He also places their liabilities, including capital stock, at $355,000.

THE RHODES MANUFACTURING CO.

The Rhodes Manufacturing Company, of Philadelphia, made an assignment on January 5. It conveys no real estate. The company was incorporated on the 10th of March last for the manufacture of electric motors. It was stated last week that the authorized capital was $200,000, of which amount it was claimed $170,000 was paid in, made up of machinery, tools, stock, real estate, and patents, the latter of which were valued at $50,000. The company's credit was good. No estimate of liabilities and assets can be formed at present.

HUDSON RIVER TELEPHONE CO.

By the termination of a lease the Hudson River Telephone Company has come into possession of the property and franchise of the New York and Vermont Telephone Company. Formerly the Hudson River Co. confined its business to the main lines around Albany. Several branch lines were leased to other companies, among them the Union, of Saratoga, and the Schenectady, Amsterdam, Gloversville, Hudson, Catskill, and New York and Vermont companies. These leases were given by the Hudson River Telephone Company when it controlled the territory over which the various lines were operated. Subsequently another syndicate was formed, which purchased the leases of all the lines except the Union of Saratoga and the New York and Vermont. There is talk of forming another syndicate to include some of the cities along the Hudson and at interior points.

GLENNS FALLS, N. Y., STREET RAILROAD CO.

At a meeting of the street railroad company held Dec. 22, the following directors were chosen: J. M. Coolidge, B. B. Fowler, W. W. Rowe, of Troy, Samuel Bolton, Jr., Peter McCarty and J. A. Powers, of Lansingburg and H. R. Leavens. The board organized as follows: President, J. M. Coolidge; secretary and treasurer, B. B. Fowler; executive committee, J. M. Coolidge, B. B. Fowler and J. A. Powers. Resolutions asking the State board of railroad commissioners to change the motive power to electricity, and also to increase the capital stock from $70,000 to $120,000 were passed.

THE THOMSON-HOUSTON AND BRUSH ELECTRIC CO'S.

The Thomson-Houston Electric Co., having fulfilled all the terms of its purchase of the Brush Electric Co., has entered upon the management of that valuable property. It is rumored that the affairs of the Brush Co. will be handled in Boston although a large staff with onerous responsibilities will be maintained in Cleveland. The *Boston Globe* of January 3, says:

"A notable change in the directory of the Thomson-Houston Electric Company took place Jan. 1, by the resignation of Mr. S. A. Barton, the organizer of the company and a member of the board since 1882. From 1882 to 1886, Mr. Barton also occupied the position of general manager and treasurer; at which time he removed to Chicago to build up a Western business. On returning in the winter of 1889 he organized a central purchasing department for the various Thomson-Houston interests, and has recently assented to taking the presidency of the Brush Electric Company at Cleveland, O., and re-organizing the same, but will not change his residence." In connection with this change of work, it is further understood that to Capt. Eugene Griffin will fall a large part of the work, as the right hand man of Mr. C. A. Coffin, under the readjustment of duties at the Thomson-Houston headquarters, and that, in turn, some of Capt. Griffin's old duties will devolve on Mr. O. T. Crosby.

DIVIDENDS.

MILFORD, MASS.—The Milford Electric Light & Power Co. has declared a dividend of 2 per cent.

STOCKS AND BONDS.

RICHMOND, IND.—The Richmond Street Railway Co. has filed a mortgage with the Union Trust Co., of St. Louis, and J. B. Dougan, a local banker, for $200,000 to secure that amount of thirty year $1,000 bonds at 6 per cent. Among those interested are J. C. Shaffer, the street railway magnate of Indianapolis, and Russell Harrison, son of President Harrison. The road is a very successful one.

THE UNION TELEPHONE CO., of Saratoga Springs, N. Y., has passed into the control of the Hudson River Telephone Co. A new local company will be formed January 14. It is proposed to spend $5,000 in improving the system.

ANGOLA, IND.—The tax-payers are seriously considering the advisability of the city purchasing the electric light plant established by private parties. The electric company is willing to sell if it receives dollar for dollar of its investment, but an offer of eighty cents for a majority of its stock by outside parties has been refused.

WOONSOCKET, R. I.—The Providence *Financial News* says Woonsocket Electric stock has recently, in a few cases in Providence, sold at $95, and adds that it is in good demand in Woonsocket at that price, will probably sell higher, and would be more active in Providence if dealers were fully acquainted with its merits.

MAYOR GRANT ON NEW YORK CITY WIRES.

In his annual report, Mayor Hugh Grant says:—The work of removing the poles and overhead wires has been continued without interruption during the past year, and in every instance in which the companies have contested the right of municipal Government to compel the removal of these poles and wires the city has been successful. The Board of Electrical Control during the past year has constructed for the reception of telegraph and telephone conductors 178 miles of single duct in nine miles of street trench, making a total construction of telephone and telegraph subways of 697 miles of duct in 38 miles of street trench. There have been constructed 132 miles of duct in 39 miles of street trench for electric light conductors, making for electric light service constructed up to date 647 miles of duct in 85 miles of street trench. There have been placed in the subways 10,150 miles of telephone and telegraph wire and 340 miles of wire for electric light service, making in all now in the subways, telephone, telegraph, and electric light wires, 23,797 miles. There have been removed during the year 1,361 poles and 18,949,645 feet of overhead wire.

At the present time many of the departments operate separate systems of electric wires, which are largely maintained through separate cables. In several of the large cities of the United States a central electrical exchange, through which intercourse can be had between the different departments of the city Government, is in existence, under the control of the local authorities. It is a question for serious consideration whether such a system should not be adopted in this city. If it should be ultimately concluded to adopt such system it could be extended to enable the city to furnish its own electric lights.

THE BITE OF AN ELECTRIC BUG.

The following dispatch from Philadelphia of Dec. 28 is of very peculiar interest as presenting another argument against overhead wires:

"Physicians and medical students have been studying with great interest a case without a parallel, so far as is known. Little Mamie Lurker, walking in Girard avenue a few days ago with her aunt, suddenly stopped, and, putting up her hands to her face, screamed, "I am shot." The aunt seized the child's hands and immediately staggered back as if she had received an electric shock. A crowd speedily gathered and a man crushed with his foot a peculiar bright-hued bug, bottle-shaped and hard-shelled, which, falling from a wire overhead, had dropped on the girl's face and stung her. A bright crimson spot, in Mamie's cheek showed where the bug had made the wound and evidently inoculated her with the electricity with which it was charged by being in contact with the wire. Little would have been thought of the accident had it not been for the peculiar symptoms of the girl, who was nervous and uneasy and whose grasp sent an indefinable tingling sensation to the hands of everybody who touched her. Dr. De Beust diagnosed the case as bullis, or vasicular poisoning, and administered the remedies usual in cases of that kind. To his astonishment, however, the bright-hued sore on the cheek was followed by other bright-hued eruptions on every part of the body, each one emitting the same peculiar tingling sensation when touched. In his opinion the bug was of a Brazilian species brought to this country in the year of the Centennial. The insect in itself is not known to be poisonous and is distinguished for its peculiar bottle-shaped appearance.

"The patient is now considered out of danger, after unremitting attention on the part of the physician, but still suffers from the inocculated electric bite."

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JAN. 6, 1891.

Accumulators :—

Electrode for Secondarg Batteries, S. C. C. Currie, 444,392. Filed June 10, 1890.

The electrode is composed of the salt or salts of a metal or metals and is provided with an integral tough and compact or dense supporting-rim of the same material or materials, distinguished from the active portion of the electrode.

Alarms and Signals :—

Electric Annunciator, A. Hormel, 444,245. Filed July 29, 1890.

An electro-magnet on the upper shank of a frame has an armature pivoted to the back part of the frame, the armature having a knob or hook on its free end with an elbow-lever having an aperture and pivoted to the lower shank of the frame, so that the lever is kept in an upright position by the knob or hook of the armature ; a lifting lever serves to raise the elbow-lever when it is released from the armature.

Signal-Box, J. C. Wilson, 444,144. Filed Jan. 14, 1888.

Applicable to signal systems including telephone circuits.

Claim 5 follows :

In a signal-box, a signal-transmitter and answer- back bell, a telephone, a shunt-switch for said answer-back bell automatically closed by the removal of the telephone, a normally-open ground branch leading from the signaling circuit for the telephone, and a switch for closing it automatically when the door of the box is opened.

Conductors, Conduits and Insulators :—

Man-Hole for Underground Electric Conduits, W. H. Hart, 443,992. Filed Mar. 22, 1890.

Designed and constructed to preclude the entrance of gas into the man-hole, and to prevent the shocks and jars due to passing vehicles from injuring the walls of the man-hole and impairing the joint between the walls and the cover.

The base or floor is constructed of material impervious to gas and moisture ; double walls are built upon such base and between them is interposed a filling of composition impervious to gas and water. A yielding gasket is interposed between the cover section and the walls.

Tightening Device for Suspended Electric Conductors, D. Mason, 444,005. Filed May 28, 1890.

Claim 1 follows :

A suspended electric conductor having a tightening device interposed therein for tightening or loosening the same, substantially as and for the purpose set forth.

The device shown and described consists of a winding drum to which the conductor is attached so as to be wound or unwound ; the drum is provided with a cog or ratchet and a detent for engaging and retaining it. The device is attached, preferably, to a hanger attached below an insulator.

Tightening Device for Suspended Electric Conductors, D. Mason, 444,006. Filed May 28, 1890.

A spring is employed to keep the conductors stretched, instead of a winding drum as in No. 444,005, above.

Claim 3 follows :

A suspended electric conductor having interposed therein a spring acting to tighten the conductor, for the purpose described.

Electric-Wire Insulating-Cleat, J. S. Potter and D. J. Cartwright, 444,317, Filed Aug. 16, 1890.

The cleat, which is formed in two parts secured to the wall or ceiling by screws passing through them and clamping them together, has the ducts or perforations tapered so as to permit the insertion of wedges to secure the wires in position.

Molding for Electric Wiring, G. Cutter, 444,377. Filed July 21, 1890.

In order to prevent the charring or carbonizing of the partitions in a molding for electric light wires—which is usually formed entirely of wood, and which is liable to cause short-circuiting—the grooves of the moulding are separated by longitudinal partition-strips of insulating material

Dynamos and Motors :—

Dynamo-Electric Machine, A. G. Holcombe, 444,067. Filed Sept. 17, 1890.

The invention is particularly applicable to alternate-current generators, and relates to the construction of machines of the class in which currents are generated by revolving electro-magnetic pole-pieces, without coils, in proximity to fixed armature coils, the exciting coils also being stationary.

Electric Motor Attachment for Reed Organs, L. K. Fuller, 444,169. Filed July 19, 1889.

Modification of the pneumatic and mechanical devices of reed-organs for the adaptation of electric motors to actuate them, including intermediate speed-reducing gearing, and including also means whereby the performer may regulate the force of the electric current supplied to the motor.

Electric Motor, C. J. Van Depoele, 444,188. Filed March 22, 1889.

Improvement or amplification of electric motor described in patent No. 443,980, Dec. 30, 1890 (see *Inventors' Record* in the ELECTRICAL ENGINEER, Jan. 7, 1891).

The present invention comprises a motor including the three elements shown in the patent above referred to ; but the induction coil for the armature instead of being the primary circuit of an inducting system is arranged in a secondary relation to the field magnets, and therefore the armature becomes a tertiary induction system ; the current in the coils of the field magnet produces a secondary current in the induction coils surrounding or embracing the armature, and such secondary currents in the induction coil induce tertiary currents in the armature, which serve to establish the requisite poles therein. The poles thus produced in the armature are located by providing a definite path or paths for the currents circulating in it, as described in the previous invention above referred to.

Lamps and Appurtenances.

Electric Arc-Lamp, A. W. Reppy, 444,104. Filed Sept. 27, 1890.

The invention relates particularly to the form of the carbons and the mechanism for feeding them, and consists chiefly in the combination, with two rotary carbons mounted edge to edge, of means for rotating and feeding them at the proper relative rates of speed.

Claim 1 follows :

In an arc lamp the combination of the two rotary carbon discs having the pinions of unequal diameters, the stationary rack engaging the smaller pinion, and the rack carried by the carbon having the smaller pinion, said rack engaging the larger pinion, whereby the carbons rotate at unequal rates of speed.

Electric Arc-Lamp, J. J. Skinner, 444,154. Filed April 27, 1886.

Relates to the class of arc lamps in which the feed is controlled by an electro-magnet independent of the one separating the carbons, the feed controlling magnet being either in the main circuit or in a shunt, according as the lamp is used in a single circuit by itself of forms one of a series.

The devices comprise a clamp pivotally connected with the armature of the feed-controlling magnet at one side of the carbon rod, and an independent lever connected at an intermediate point of its length with a fulcrum, and having one arm in position to be engaged by the armature of the feed magnet and its other arm in position to engage with the free portion of the clamp.

Support for Electric Lamps, J. Chase, 444,330, Filed May 17, 1890.

A device designed to hold out-door arc lamps firmly in position during high winds, avoiding swinging or vibration ; also to secure perfect electrical contact during the raising or lowering of the lamp.

Electric Switch, C. E. Wilson, 444,874. Filed Sept. 18, 1890.

A design and construction for a positively acting switch for incandescent light systems, the parts of which are all of such simple construction as to be punched out and assembled at small cost.

Metallurgical :

Magnetic-Ore Separator, C. Q. Payne, 444,223. Filed Aug. 19, 1890.

Designed to obtain a more perfect concentration of lean or low-grade iron ores. The electro-magnets are constructed in the main with a view of securing a better arrangement of the lines of force in the magnetic field in which the separation takes place.

Claim 1 follows:

In a magnetic separator, two segmental ring-shaped pole-pieces magnetized, respectively, by positive and negative polarity and placed concentrically, so as to constrain the lines of force to occupy positions normal to their adjacent surfaces.

Miscellaneous :—

Electrical Range-Finder, B. A. Fiske, 444,217. Filed June 25, 1890.

Invention embraces the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon a distant object, and simultaneously causing a disturbance in an electrical balance including said body in its circuit proportional to the resistance of said fractional portion, and, observing the difference in potential in the circuit due to the disturbance. Provision is made for reading directly from a suitably marked scale of an electrical measuring instrument constructed to measure the amount of the disturbance.

Electric Agricultural System, E. M. Bentley, 444,265. Filed May 11, 1888.

The invention relates to a system of the same general type as that shown in the same inventor's patent number 382,941 of May 15, 1888, which included two supply wires suspended upon opposite sides of a field and an electrically actuated machine driven forward and backward across such a field and provided with electrical connection with the two opposite wires. The present invention consists in arrangements for applying the system above referred to to a large number of fields to be operated simultaneously or successively. It consists partly in details of devices for electrical connection of the machine and the supply wires and partly in a specific form of machine by which a plow or similar agricultural instrument may be operated.

Registering Mechanism, or Counter Actuated by Electric Currents, R. Jewell, 444,358. Filed June 20, 1890.

An application of electro-magnetic mechanism to actuate a registering or counting machine embracing one or more dials.

Railways and Appliances :—

Brake for Electric Cars, B. L. Randall, 444,110. Filed Sept. 11, 1890.

Consists in mechanism to enable the driver when applying the brake to cut off the power automatically and simultaneously. The shutting off of the current is governed directly by the action of the brake.

Current-Collecting Device for Electric Railways, R. M. Hunter, 444,397. Filed Sept. 24, 1890.

Consists essentially of the employment of iron wires as working conductors—suitably connected at intervals with supply conductors—and of trolley wheels of iron in contact with the poles of electro-magnets carried on the trolley-pole ; the motor current passing through the electro-magnet ; with a view of securing the best possible contact between the trolley-wheels and the working conductor.

Telephones and Apparatus :—

Signaling Apparatus, I. H. Farnham, 444,108. Filed Aug. 20, 1890.

Relates to telephone circuits of the class in which a number of stations are connected upon one line, and particularly adapted to metallic circuits. The invention includes an electro-magnetic call-receiving device located at each station in a permanently closed bridge or branch of the circuit, and a call-sending generator at each station in a normally open bridge or branch of the circuit, parallel to the above mention closed bridge or branch, and means for closing the generator circuit to send an out-going signal, and for simultaneously increasing the resistance of the parallel bell-branch circuit at the same station.

ELECTRICAL PATENTS EXPIRING IN DECEMBER, 1890.

Telegraph Cut-Out, W. G. Lion, No. 145,064, December 2, 1873. *Telegraph Register*, W. H. Sawyer, No. 145,128, December 2, 1873. *Non-Freezing Battery*, E. H. Ashcroft, No. 145,143, December 9, 1873. *Electric Signaling Apparatus for Railways*, F. L. Pope, No. 145,308, December 16, 1873. *Telegraph Transmitter*, D. Hermann, No. 145,567, December 16, 1873. *Lightning Rod*, J. Drew, No., 145,851, December 23, 1873. *Telegraph Insulator*, Fox and Heston, No. 145,997, Dmber 30, 1873.

"THE SCHOOL BELL."

The above is the title of an excellently printed and cleverly edited newspaper of 8 pages, issued by the young folks at Arlington, N. J. We are indebted for a copy of it to Mr. George A. Wiley, of the Standard Underground Cable Co., an old resident of Arlington. The paper is full of pretty little articles and poems, and we wish to commend specially the article by Master F. E. Suderly, on "Electricity and its Uses." When the coming generation of citizens can show the appreciation of the benefits of electricity that this article evinces, electricians need have no fear as to the future of their art. There is also a good essay on "Journalism," by E. P. Fredericks.

NEW YEAR WISHES.—The London *Electrical Review* has issued a neat card of New Year wishes to its contemporaries. Up in one corner is a projector, whose brilliant beams suggest the fierce white light of publicity that a modern journal throws upon things within its ken.

Legal Notes.

PAYMENT FOR STREET PAVING BY STREET RAILWAY COMPANIES.

Notice has been served by the city, on the Omaha Motor Line Co. to the effect that a suit is to be begun in the Superior Court to force the company to pay $7,000 due for the paving of street intersections over which the line runs. The contention is that under the State law the company is liable for the paving of their tracks and for a foot outside. The motor company claims that the cars do not make any wear on the streets, all the wear falling on the tracks.

I. A. BARNES vs. CARPENTER-NEVINS ELECTRO-HEATING CO.

Isaac A. Barnes, the attorney, is the plaintiff in a suit soon to be brought against the Carpenter-Nevins Electro-heating Company, to recover $10,500. About six months ago, Barnes, after hearing glowing accounts of the company's success from the lips of Frank W. Nevins, secured 50 shares of stock, giving in exchange $500 and real estate which he says was worth $6,000. He also says that Nevins represented that the company was magnificently prosperous, and made other misrepresentations: for instance, that the wire coiling, an important part of the apparatus, would last 10 or 15 years, when, in fact, its life is only about two months. Barnes sues to recover the property and money invested and $4,000 damages additional.

BRUSH-SWAN CO., OF N. E. vs. BRUSH ELECTRIC CO.

In the action of the Brush-Swan Company of New England against the Brush Electric Company of this city, Judge Coxe, of the United States Circuit Court, New York, on Jan. 2, granted an order permitting the defendants to sell their apparatus as fast as manufactured, and requiring them to pay over to the plaintiff 20 per cent. of such sales. The plaintiff is required to file a bond in $25,000, and in the event of their failing to do so, the percentage must be paid into the registry of the court and remain there to await final action of the courts.

THE GOVERNMENT TELEPHONE CASE.

The annual report of the Attorney-General of the United States, dated Dec. 1, 1890, contains the following paragraph:

"As foreshadowed in the last report, the taking of evidence in the case of the United States against the American Bell Telephone Company and Alexander Graham Bell was commenced very shortly after that report was made, and has been prosecuted diligently ever since. The evidence on behalf of the Government has not as yet been completed. The defendants decline to agree, and the court declines to order that the testimony be taken by a stenographer. The cross-examination of the government's witnesses is greatly protracted, with the probable effect of delaying the progress of the case so that no decree can be reached before the expiration of the defendants' patent. Seventy days have been occupied by the defense in the cross-examination of one witness, and the cross-examination is still going on at the date of this writing. The case will be pushed as rapidly as possible under the circumstances."

At Boston on January 6 before Judge Colt, the plaintiff moved for an order of court that the time allowed for taking testimony be extended in this case to April 1. There was now a hearing upon the motion, and the judge ordered the time extended to April 1. C. S. Whitman for the plaintiff; G. L. Roberts for defendants.

W. TAYLOR vs. NEWARK, O., AND GRANVILLE ELECTRIC ROAD.

At Newark, O., on January 5. Judge McElroy rendered his decision in the case of Waldo Taylor against the Newark & Granville Electric Road. The case has attracted widespread attention. Taylor asked for an injunction restraining the issuing of stock on bonds and applied for the appointment of a receiver, setting up the usual charges in such cases. After a lengthy review of the case the application for an injunction is refused, the petition dismissed and the motion for a receiver overruled.

A REVIEW OF RECENT STORAGE BATTERY LITIGATION.

With regard to recent storage battery litigation and the statements made in regard thereto, Mr. D. H. Bates, president of the Electrical Accumulator Co. says, of the report of Judge Brown's decision at Cleveland, O.:

Meanwhile, the suits instituted by The Electrical Accumulator Company against the Brush Company in the Ohio District to determine the respective standings of the Faure and Brush patents had, owing to dilatory proceedings instituted in great part by the defendants, progressed no farther than the preliminary pleadings, and the merits of the case have not been brought into question, and no testimony has been taken. It is in this case, that Judge Brown has made an interlocutory decision, involving three questions of law and fact, as follows:

The Accumulator Company applied to the court for leave to dismiss the two interference suits, alleging that, owing to the construction placed upon the Faure patent by Judge Coxe, there no longer remained any interference. In one of these cases, namely, the one in which the Faure patent was in interference with the Brush patent, 337,298, the court decided the motion in favor of the Accumulator Company; in the other case, Judge Brown held that the question of the expiration of the Brush patent, by reason of the prior grant of the Italian patent, could not be decided until after full hearing and hence sustained the demurrer of the Brush Company to that portion of the Accumulator Company's bill, leaving the case to proceed on its merits.

In the same case the Accumulator Company filed a supplemental bill, setting up that since the disclaimer filed to the Faure patent, there was no longer any interference between the first claims of the Faure patent and the formerly interfering claims of the Brush patent. The Brush Company filed a demurrer to that supplemental bill, on the ground that this question could not be tried in that case, and Judge Brown also decided this question in favor of the Accumulator Company.

The facts are, therefore, that in the recent case three points have been decided, two in favor of the Accumulator Company and one in favor of the Brush Company, leaving the case still to be tried on its merits.

The Accumulator Company claims, and its claims are based upon a long and wide experience in the business, that no form of storage battery so far made has proved or can prove successful, except that made by the Faure process where the active material is supplied to the support plate in the form of a paint, paste or cement prior to immersion in the battery fluid, and that where, according to Judge Lacombe's construction of Brush's experiments, a perfectly dry power is compacted upon the grid by a hydraulic pressure and no fluid added until the plate goes into use in the battery, the absorption of the fluid by the active material causes it to expand and to exhibit a tendency to disintegrate, such tendency being accelerated on the occasion of each succeeding charge and discharge. In other words, a battery so constructed is not durable and breaks down when subject to any but ordinary strain.

PUMPELLY STORAGE BATTERY.—Wm. J. Brown has begun suit at Detroit on a judgment against the Pumpelly Storage Battery & Electric Motor Co., of Illinois, for $15,000 damages.

A TRIAL FOR EMBEZZLEMENT.—A special dispatch from Sioux Falls, S. D. of January says: The trial of E. J. Mannix, ex-manager of the Western Union Telegraph office in this city, was begun yesterday. The charge is the embezzlement of $3,472. The Western Union is making a bitter fight to secure the conviction of Mannix, who is resisting with able attorneys. Evidence is being introduced by the Western Union people to show that a conspiracy existed between a dozen telegraph points in South Dakota, and that Mannix was one of the principal conspirators.

UNION OF ALUMINUM AND GLASS.

A special dispatch from Cincinnati of Jan. 8, says: Bradford McGregor, the mechanical expert of this city, has succeeded in uniting aluminum with glass, and he claims to be the first who has done so. A large piece of the aluminum with a glass tube in the centre was turned in his lathe, and it was impossible to detect the joint where they united. Heretofore no metal could be made to unite with glass in which the contraction and expansion were the same, and it is claimed that this will create a revolution in the way of reducing the cost of incandescent lights, as it will take the place of platinum, which costs $320 a pound, while the new discovery will cost only $10.

ANNUAL ELECTION OF THE MAGNETIC CLUB.

The annual meeting of the Magnetic Club was held January 8. President Dealy, though nominated, declined re-election and anticipating that the members would favor and second his desires, made a requisition in due course upon the W. U. superintendent of supplies for the services of Mr. E. C. Cockey as president. The nomination being made, Mr. Cockey's election was enthusiastically and unanimously made. The vice-presidents are W. H. Baker, W. L. Ives, M. J. O'Leary and T. E. Fleming; secretary, G. F. Fagan; treasurer, J. Brant.

HOLTZER-CABOT CO.

The above enterprising Boston concern have issued a very handsome calendar, the engraving upon which is after one of the best of Landseer's Highland deer pieces. It shows also the fluctuations of the moon. It is worthy mention that the company issues a remarkably fine catalogue of its productions, which should be applied for when writing for a calendar.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Be liberal with your publisher; candid with your public, and Heaven will send you customers."

THE "CHAMPION" PRIMARY BATTERY.

THIS is the name of a new primary battery of the sal ammoniac type which has recently been improved by Mr. C. J. Hirlimann, of No. 91 Greene street, this city, one of the original manufacturers of the Leclanché batteries in this country. The accompanying engravings illustrate the new "Champion" cell, which is made up in two distinct patterns; the difference, however, lying only in the form of the zinc. Thus, it will be seen that in one form, Fig. 1, the zinc consists of the ordinary rod zinc, while the other has a large surface of corrugated sheet zinc, Fig. 2.

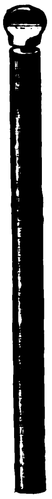


FIG. 1.—ROD ZINC OF CHAMPION BATTERY.

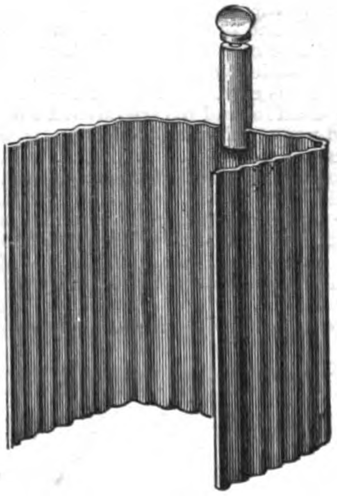


FIG. 2.—CORRUGATED ZINC OF CHAMPION BATTERY.

When the rod zinc is employed the battery is most suitable for telephone work, and where a constant output of energy is required, while the corrugated zinc is used where large quantities of current for a short time is the desideratum, as in gas lighting work, electric bell ringing, etc. In further support of the merits of the battery a measurement of the cell by the well-known electrician, Mr. George d'Infreville, of this city, is given as follows: Electro-motive force, 1.4 volt; internal resistance, .17 ohm; current, 8.3 amperes.

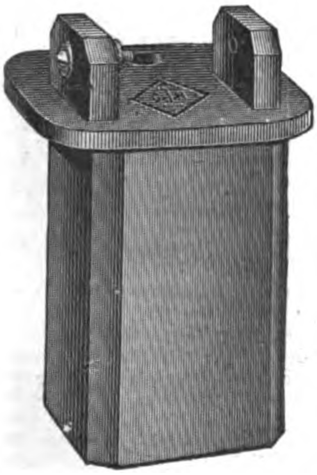


FIG. 3.—CARBON RESERVOIR OF CHAMPION BATTERY.

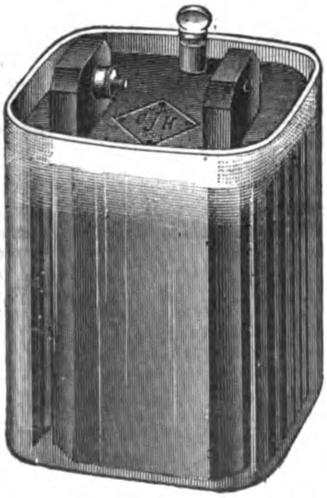


FIG. 4.—COMPLETE CELL OF CHAMPION BATTERY.

It is needless to say that if these figures can be depended upon uniformly in all the cells of this battery manufactured, the Champion battery will be a valuable acquisition to the trade, and Mr. Hirlimann, so far from having any doubts in this regard, states that by a special process through which the carbons are put after baking, there will, if anything, be an increase in the amperage of his cell beyond the official report above given.

The carbon reservoir, Fig. 3, is quadrangular in shape and charged with ingredients under a secret formula, and is provided with a neat top, fitting closely into the glass jar, to prevent evaporation and facilitate sealing, as shown in Fig. 4.

The Champion battery, both with rod zinc and corrugated zinc, will be on sale at all prominent supply houses in this country, and patents in Europe, we understand, are applied for.

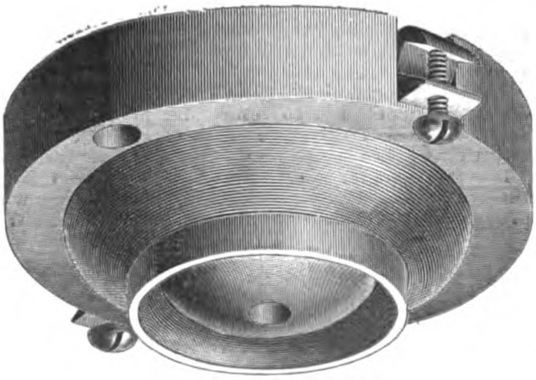
THE PAISTE IVORY CHINA SWITCHES.

H. T. PAISTE, manufacturer of the well known Paiste specialties, is now placing on the market a switch, the handle, cover and base of which are made of English ivory china. The switches are very neat and artistic, and designed for fine residence installations. They are furnished in all colors, to match wall paper and felts. Those with the dull gold finish are particularly fine. The demand for these goods has been so great that 500 are being imported weekly. One noticeable feature is that the cap screws on the base with a thread cut in the china. Mr. Paiste claims for these switches that they will always present a fine appearance, as the china cover will not tarnish, as all metal caps do in time when exposed to atmospheric changes.

THE PAISTE IVORY CHINA SWITCH.

A NEW PETTINGELL, ANDREWS CEILING BUTTON.

WE illustrate in the accompanying engraving a new ceiling button which is being introduced by the Pettingell, Andrews Company of Boston. This button does away with the necessity of cutting the wires and making a soldered joint to the flexible cord.



NEW FORM OF CEILING BUTTON.

As will be seen the cord is put through the hole in the centre of the button and is fastened by screws to the inside ends of the clamps. The clamps themselves are for the reception of the main branch wires and are put in circuit like the ordinary K. W. cut out.

W. H. GORDON & CO.

W. H. Gordon & Co., 115 Broadway, carry a full line of the Star Electrix specialties. The new socket is going like hot cakes as the construction men seem to appreciate the fact that this socket can be connected up in a short time. It is only necessary to loosen two screws to get at the connections.

A GOLD MEDAL FOR "INTERIOR CONDUITS."

The recent demonstration and tests of the conduit system of wiring made by the Interior Conduit & Insulation Company, of New York, in the city of Chicago, before the city authorities, electrical experts, insurance representatives, and later before the Illinois Chapter of Architects, were very elaborate in detail, and were the means of convincing all who were fortunate enough to be present of the superiority of the system for electric light wiring. Prof. John P. Barrett, superintendent of city telegraph of Chicago, endorses the system as follows:

CHICAGO, ILL., Dec. 24, 1890.

INTERIOR CONDUIT & INSULATION CO., NEW YORK,

Dear Sirs:—

After careful examination, I beg leave to say I thoroughly endorse the system of the Interior Conduit & Insulation Company for inside wiring. I further would state that the method of running the two branch wires in a single tube for incandescent electric wiring is approved by me, and I will cheerfully pass any electric installation that is equipped with this system, believing it to be the safest method of interior wiring yet devised.

The appliances of the system are worked out in a manner which insures not only safety but easy accessibility at all times.

Yours respectfully,
J. P. BARRETT, Supt.

P. A. Sowden, superintendent of surveys, Chicago Fire Underwriters Association, was so much pleased with what he saw that he wrote as follows:

INTERIOR CONDUIT & INSULATION CO., NEW YORK,

Dear Sirs:—

I have also examined the system of the Interior Conduit & Insulation Company, and agree in every respect with Mr. J. P. Barrett, and highly recommend your system of interior wiring.

T. A. BOWDEN,
Supt. of Surveys,
The Chicago Fire Underwriters Association.

The Interior Conduit & Insulation Company have recently received a gold medal, first award, at the Mechanics' Fair Association, of Boston, Mass., for their admirable system.

TEYGRAPH V. DUSMILKCOW.

The above is not the name of any recent distinguished arrival from Russia, but is the composite appellation lately assumed and worn proudly by the aggregation of talent that comprises the staff of the progressive Electrical Supply Co. in Chicago. It includes all the letters in his respective surnames, and, as will be seen, presents at once suggestively and graphically the peculiar combination that Chicago fascinates the visitor with, of modern inventions and facilities, alongside the most innocent of rural occupations. In business this energetic gentlemen are hustling like ten little niggers, and then on going home to dine in the evening they beguile his pastoral hours in the suburbs by milking cows. As an accompaniment for their composite name, this accumulated individual has sent us also their composite photograph, which "represents us as we are," he says. The portrait is strikingly attractive in its blend of youthful, manly beauty, with the chiseled serenity of wise old age, due to the fact that the combined years of the nine and his umpire reach about 250. There is also something peculiarly Chicagoan in the keen alertness of the upper part of his face and the soft tenderness that plays around the lower part of their physiognomy. The motto under the portrait is as novel and original as the method thus adopted of sending New Year wishes, while the verses prove that another Sweet Singer has risen in the West.

THE HUNT ENGINEERING CO.

The Hunt Engineering Company, of Brooklyn, N. Y., was incorporated on January 1st, 1891, with a capital of $30,000, the incorporators being George W. Hunt, Albert E. Rich and T. Leeds Waters, all of Brooklyn, and the directors for the first year, Hiram W. Hunt, De Witt N. Cole, George W. Hunt, Albert E. Rich and T. Leeds Waters. The company have moved from their old offices, 177 & 179 Montague street, into new quarters, taking a commodious three-story building at 238 Washington street, which will give them every facility for carrying on their rapidly growing business. They have recently brought out a new improved lamp socket to fit either a Thomson-Houston or a Westinghouse lamp. Messrs. Alexander, Barney & Chapin, of New York, have taken the general agency for this socket.

The company have also under course of construction several new and approved snap switches and other appliances, which they will manufacture and keep in stock, and for which there will doubtless be a ready demand. The Hunt Engineering Company have done construction work for isolated plants and central stations from Brunswick, Maine to Charleston, S. C., averaging about 1800 lights per month, and start in on the new year well equipped in every way for a large and prosperous business.

MORE CHANGES ON "THE ELECTRICAL WORLD."

The following notice in *The Electric Age* of last week will interest a very large circle of electrical readers:

> Mr. Walter T. Hunt, who for the past seven years has been manager of the advertising department of our contemporary, the *Electrical World*, has severed his connection with that paper and assumed a like position with *The Electric Age*. Mr. Hunt is so well known in the electrical trade that it is hardly necessary now to formally introduce him.

This news will probably not surprise anyone who has watched the course of events during the past year in electrical journalism, and Mr. Hunt is to be heartily congratulated on making this change of base while he can still point to the evidences of his good work and to the success he achieved in the special sphere of labor that he now deems it prudent to quit. A more loyal, energetic and wideawake advertising agent than Mr. Hunt cannot be found in this city, and though he can only at this juncture carry his reputation and his friends with him, if nothing else, he may depend upon it that before long a large share of his old business will naturally have followed him, too. The fault will not be his if it doesn't, and he is fortunate, moreover, in being associated with the Messrs. Taltavall, who have already shown their ability, before enlarging their field, and issuing also their electrical journal, by conducting the brightest and best telegrapher's paper ever seen in America. Mr. Hunt will be accompanied in his new departure by the wishes of many who, like ourselves, have watched his career, and know the sterling stuff he is made of. He may count on finding his services appreciated ungrudgingly and without any of the sneering discouragement that often besets honest endeavor and takes the heart out of even the best of us. Mr. Hunt, we understand, is Vice-President and Manager of the Advertising Department of the *Age*.

On Saturday evening, January 10, Mr. Hunt tendered a number of his journalistic friends a dinner at Martinelli's, in recognition of the many expressions of kindness and good will that had reached him from them on the announcement of his change. The evening was spent very pleasantly, and wound up with an hour at the Electric Club.

MR. E. T. COPELAND.

Mr. E. T. Copeland, for the past 12 years general agent of the New York Safety Steam Power Co., announces his establishment of new quarters at 106 Liberty street, corner Church, with superior lines of steam engines, boilers, etc. He invites customers old and young to visit his sales and exhibition rooms.

MR. J. F. MORRISON.

This gentleman, so well known in connection with various electrical enterprises, has decided, for the present at least, to close up his business connections with the various Baltimore enterprises with which he has been connected. Probably the best known among these is the Southern Electric Co., which was established by Mr. Morrison as a supply company in 1879. In 1882 Mr. Morrison associated with himself Mr. D. H. Tuxworth, of Baltimore, the firm carrying on business under the old name. For the past six years other enterprises have so claimed Mr. Morrison's attention that the time devoted to the interests of the Southern Electric Co. was necessarily very limited. He has therefore finally decided to sever his connection with the company, which action took effect January 1st. Mr. Tuxworth assumes all the responsibilities of the Southern Electric Co. from that date.

EDWARD R. KNOWLES, C. E.

Mr. Knowles, who has had a practical experience in various branches of engineering and patent matters for over 18 years, and particularly in electrical work for ten years, has opened an office recently at 181 Broadway, this city, for the transaction of a general expert engineering business. He will undertake any professional work falling within his field, and is competent to begin with the inventor's crude idea, help him work it up, get him a good patent, place the device on a practical working basis, and offer good advice as to further development or as to fighting off infringers. Having known Mr. Knowles throughout his electrical career, we do not hesitate to recommend his services highly.

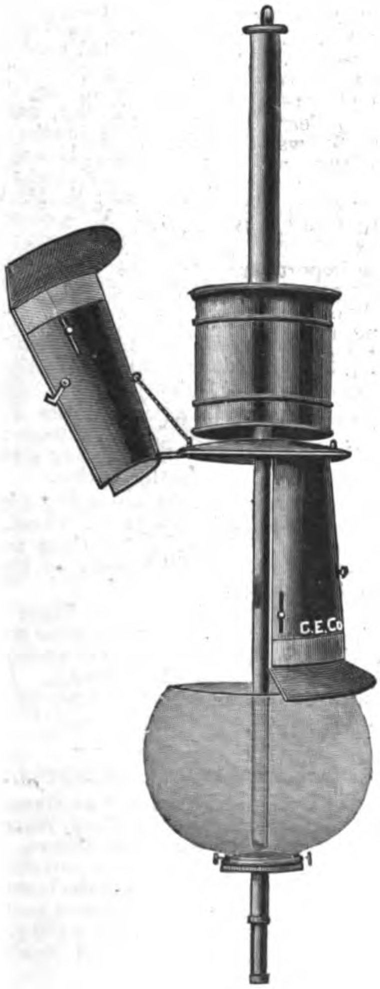
THE COMMERCIAL CABLE CO.

We are indebted to Mr. George G. Ward, general manager of the Commercial Cable Co., for a copy of the handsome big calendar issued by his company. It is in the diamond shape they have adhered to, and the calendar tablet is prefaced with a little greeting in keeping with the season. At the back of the tablet are several fly leaves giving a variety of information likely to be of use to those who use ocean cables.

THE ROBERTSON CARBON PROTECTOR.

The cut shows an ingenious device for protecting carbons and carbon rods from the effects of sleet and snow. The protector is made of galvanized sheet-iron and japanned, and is strong enough to withstand a great deal of hard usage.

At the bottom is an extension feature that permits the protector to be adjusted to almost any size of lamp, and the cut shows one side thrown up to allow the trimmer to give the lamp necessary attention. The lower flange is also shown partly extended. Several hundred of these protectors have been in use in Minneapolis for some time and have given perfect satisfaction. The device can also be used as a spark arrester.



The Robertson Carbon Protector,

The Central Electric Company, of Chicago, are introducing the article.

THE WHELESS CONDUIT RAILWAY SYSTEM IN A SNOW STORM.

The operation of the electric roads during the late snow storms was closely watched. Reporting the state of affairs at the National Capital the *Washington Post* says of the Wheless system: "The conduit system made the best showing during the snow-storm of Friday. Although the conduit was filled with snow and sleet, the current was not dissipated. * * * The conduit line did not miss a trip during the storm."

MUNICIPAL LIGHTING PROPOSED FOR QUINCY, MASS.

Mayor Fairbanks, of Quincy, in his annual address says:—"Light has become a necessity, and there is no true business reason why a city should not only have the right of furnishing light as a protection to travel on its highways, as an aid to its police force, but also to supply its surplus to private citizens. I am aware of the many obstacles apparently in the way, but I think the council can render important service to the city by studying this problem, and become acquainted with the steps being taken in other cities to accomplish this one object of properly lighting our city."

PERRET MOTORS FOR PUMPS AND ELEVATORS.

A 20 h. p. Perret multipolar low speed motor has just been placed in the Hamilton Club Building, Brooklyn, to operate the pump of a hydraulic elevator, superseding a motor of another make. The company is now filling orders for motors from four different elevator builders. These low speed machines are rapidly coming into favor for the operation of elevators, some being connected direct to the screw shaft of passenger elevators and some being belted to power elevators in the ordinary manner. They are giving great satisfaction under all these methods.

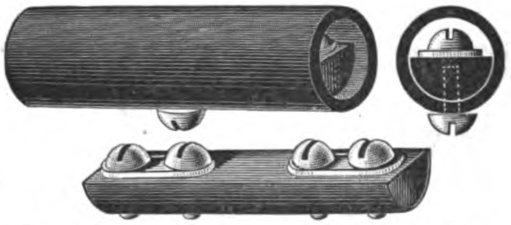
The motors are now equipped, unless otherwise ordered, with self-oiling bearings and with self-feeding carbon brushes, which require practically no attention or adjustment, thus avoiding all the difficulties with brushes sometimes experienced by those unfamilar with motors.

GREENBERG—CARNOTT.

Mr. A. G. Greenberg, special agent of the Fort Wayne Electric Co., was married to Miss Eleanor Gertrude Carnott, of Brooklyn, on December 17th, at the home of the bride's parents. After the ceremony the happy couple started South to enjoy their honeymoon. The many friends of Mr. Greenberg will be pleased to hear of his advent into the ranks of the Benedicts, and hundreds of well wishes will accompany the young people as they set sail on the matrimonial sea.

THE "MIDGET" COVERED FIXTURE CUT-OUT.

Among the recent productions of the Emerson Electric Mfg. Co., of 513 Elm street, St. Louis, Mo., is their "Midget" covered fixture cut-out, illustrated herewith, full size. This hard rubber cut-out is for electrolier and gas fixture work and to conform with the requirements of the fire underwriters. It is extremely small and compact. The cover is an important feature and will prevent much trouble from "grounds" in fixture work. The screw which holds the cover in place is tapped into both the cut-out and cover, and does not drop out and get lost, when loosened to remove the cover. It is substantially and well made, and while small size is the chief feature, the design provides for ample fusing break, long screw threads and sufficient room inside the cover for the wire.



The "Midget" Covered Fixture Cut-Out.

THE COMMERCIAL ELECTRIC COMPANY, OF DETROIT.

The Commercial Electric Company, of Detroit, Michigan, electrical engineers and contractors, have recently installed the following incandescent electric lighting plants: E. S. Fitch & Co., E. J. Hargraves & Son, Green & Bramen, Edmund Hall, Bousfield & Co., all of Bay City, Michigan; P. L. Sherman & Co., of Lidwood, Michigan; A. J. Douherty, of Clare, Michigan; Peninsular Car Co., of Detroit, Michigan, and are now fitting out the laboratory of Parke, Davis & Co. for 500 incandescent lights. Both their construction and supply departments are doing an excellent business and the prospects for business next year are very favorable.

THE "UNIVERSAL" ARC LAMP.

The "Universal" Arc Lamp Co., 49 West 22d street, this city, are meeting with considerable success in the introduction of their new style of arc lamp for incandescent circuits. These lamps are now on trial in the large Edison stations at Boston and Philadelphia. A number have also been sent to the station at Amsterdam, N. Y., where they are giving very good satisfaction. These lamps burn two in series on 100 and 110 volt circuits, and require but 9 amperes of current.

Mr. C. B. Hanna, the general agent of the Carpenter-Nevins Electric Heating Co., of Minneapolis, Minn., reports the equipment of seven cars with their well-known system of electric heating apparatus for the Tacoma and Steilycoomb Street Railway Co., of Tacoma, Wash.

QUEEN & CO.

Queen & Co., Philadelphia, have just finished "taking stock," and are congratulating themselves that in spite of the general dulness in business during the past three months their sales have been greater than ever before, and the demand for their specialties is increasing month by month.

Their standard resistance boxes, portable testing sets, ammeters and voltmeters, photometers, both portable and stationary, are of such a quality as to demand at least careful consideration, and large orders are received from all parts of the United States, as also for export.

In addition to manufacturing a full line of instruments of the regular types, they are continually engaged in designing new apparatus to meet the ever varied wants of the electrical engineer.

In this connection should be mentioned the new testing laboratory which Queen & Co. have added to their establishment. The room heretofore used for such purposes proving too small for the increasing work, a large isolated apartment has been built, which will contain everything necessary for first-class work.

Queen & Co.'s factory is one of the finest in America, devoted to the manufacture of scientific instruments. Skilled workmen are employed, and the lathes and other tools are the best and most complete. Close attention is given to the making of apparatus for special work after designs or specifications furnished, or they will design instruments to fulfill special requirements. With Prof. Anthony as consulting electrician in addition to the competent corps at their headquarters they are certainly well prepared to handle their large and increasing business.

MR. F. SARGENT, CHICAGO.

Mr. Frederick Sargent, the well-known mechanical and electrical engineer, Owing's Building, Chicago, has just been officially appointed electrical engineer-surveyor for the Western district, which comprises the great lakes of the United States Standard Steamship Owners', Builders' and Underwriters' Association. The selection of Mr. Sargent for this responsible position is a most timely one, as his reputation in electrical and engineering work is widespread all over the country.

He has had a most extensive experience in marine engineering. This is the only association that inspects under well framed rules electrical installations in vessels.

In land installation inspection has become a prime and indispensable factor of the greatest value to all concerned, and the same necessity for inspection exists on steamships. Those interested in marine installations should see to it that the work is carried out under the eye of a competent inspector, thereby ensuring thorough and proper workmanship.

Mr. Frederick Sargent has also just completed plans of the new South Side Edison station at 26th Street and Wabash avenue, and the whole plant will be built in accordance with the same and to the specifications of Mr. Sargent, who is consulting engineer of the company. He has also furnished plans and specifications for a new arc light plant for the People's Light & Power Co., of South Chicago.

ARMINGTON & SIMS ENGINE CO.

The *Providence Journal* in its admirable yearly review of local growth says: The Armington & Sims Engine Company report about the same story as told a year ago; a constant, steady increase of business. There has been no time during the past year when they have not had a very large number of orders booked, and the amount of business done shows an increase of fully 33 1-3 per cent. over 1889. As the demand increases they have gradually increased their plant and facilities, until they now have the largest and best equipped concern in the world for their especial line of work. They have a large amount of work in progress, not only for their standard high-speed engines, but also special engines of large sizes for electric power stations and large triple compound engines for rolling mills. The outlook for the coming year is favorable for a very large business."

A NOVEL FEATURE FROM THE NASSAU ELECTRIC CO.

A striking and novel electrical effect was produced at the Amphion Theatre, Brooklyn, on Tuesday of last week, in the play called "Jenny Daw," by the Hattie Harvey Company, in the shape of electric canes and umbrellas carried by the performers. Small incandescent lamps were placed in the handles of the canes and umbrellas and at a given signal they were flashed up, producing a weird and beautiful effect. These canes and umbrellas were manufactured expressly for this performance by the Nassau Electric Co., No. 19 Park Place, this city.

Gibbon Duplex Rails.—Arrangements have been made by the Gibbon Duplex Rail Co., of this city, with the Illinois Steel Co., of Chicago, to roll the Gibbon duplex rails for the West, and with the Tidewater Steel Co., of Chester, Pa., to roll those used in the East. By this arrangement a great saving is to be effected in the item of freight.

WESTERN TRADE NOTES.

Mr. George Cutter has returned from a highly successful business trip to the East and is now busily engaged preparing to meet a large demand for his many patented specialties. He is now fitting up a shop in the most complete and thorough manner in which these will be manufactured on an extensive scale, and he will soon place them on the market in very large quantities, together with the many new and good things which he has in store for '91.

The Electrical Supply Co, Chicago, have issued to their many patrons and friends a most beautiful souvenir for the new year. It consists of a handsomely printed card of eight pages, the prominent feature being a composite photograph of the ten gentlemen who are at the heads of the various departments, as follows: F. S. Terry, manager; Wm. Taylor, assistant manager and Electric Railway Department; Wells Goodhue, Electric Light and Power Department; W. R. Pinckard, House Goods Department; H. D. Ames, Accounting Department; Charles Wirt, Electric Light Engineering Department; M. M. Wood, Electric Railway Engineering Department; G. W. Conover, Purchasing Department; G. G. Carter, Sales Department; D. D. Merton, Advertising Department. That the Electrical Supply Company are artists in getting up attractive souvenirs and the like has long been an acknowledged fact by all who have perused their many and striking novelties in this line, but they have excelled themselves in their last unique effort. In a few fitting words of friendly greeting they introduce themselves in their unity as they appear to the great electrical fraternity.

The Illinois Electric Material Co. are kept busy filling orders for poles, "Canvas-jacket" and Bishop wire, and their other numerous specialties. They are placing a very efficient and economical incandescent lamp on the market.

The Electric Merchandise Co. are doing a brisk business in electric railway supplies of all kinds to which business they devote themselves exclusively. Inquiries for their new "mammoth catalogue" are numerous. It will contain an immense fund of the most useful information.

"**The Age of Steel**," published in St. Louis, an old technical journal of established merit and ever renewing enterprise, salutes the New Year with a most interesting issue largely devoted to the industrial growth and progress of the South. It is replete with valuable statistics, and as all the articles are by authorities, the opinions and deductions are entitled to unusual consideration.

NEW ENGLAND TRADE NOTES.

The National Pipe Bending Co., of New Haven, Conn., manufacturers of the well known National Feed Water Heater, have opened a branch office at 8 Oliver street, Boston, under the charge of Mr. T. P. Lennox. Among the most recent sales of Mr. Lennox in this territory, are a 600 h. p. heater to the Lowell Electric Light Corporation, Lowell, Mass., a 500 h. p. heater to the Edison Illuminating Company, of Newport, R. I., and a 200 h. p. heater to the Newburyport Street Railway Company, of Newburyport, Mass., for their new electric railroad.

The Standard Electric Company of Vermont have sold a 500 light plant to the Washington Market Company, Washington, D. C. The plant will be used for lighting the armory and the cold storage part of the market building.

The Germania Electric Co., of Marlboro', Mass., has been formed to go into the business of manufacturing incandescent lamps. Mr. George Fred. Williams is counsel for the company, and among its promoters are Messrs. H. B. Endicott and Winslow Warren, of Dedham.

Mr. H. F. Parshall, formerly general manager of the Wenstrom Electric Manufacturing Company, at Baltimore, has entered the service of the Thomson-Houston Electric Company, and will be stationed at Boston.

Messrs. S. C. Nightingale and Childs are extremely busy at present furnishing their magnesia covering for steam pipes in a large number of electric light and power stations throughout New England. Steam engine manufacturers also are using it in large quantities for covering the cylinders of their engines, and find it a most efficient preventative of radiation of heat.

ST. LOUIS TRADE NOTES.

Wr. A. W. Dutton, the Southwestern representative of the Brush Electric and the Short Electric Railway Companies, has closed a contract for an electric road at Texarkana, Ark., also a No. 4 steamboat plant for the new steamer "City of Sheffield," of the St. Louis and Tennessee River Packet Co.

The Emerson Electric Manufacturing Co. are now manufacturing the Bagnall trolley crossing, which has been adopted by the Lindell Railway Co.

Mr. H. P. Broughton, a Cornell University man of '90, has taken the agency for Chadbourne, Hazelton and Co., and The Consolidated Electric Storage Co.

THE
Electrical Engineer.

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THE INVENTORS OF THE ELECTRIC MOTOR.—III.

WITH SPECIAL REFERENCE TO THE WORK OF THOMAS DAVENPORT.

BY

Franklin Leonard Pope.

RANSOM COOK, the new partner in the enterprise, was in many respects no ordinary man. A native of Connecticut, he had been brought to the state of New York by his parents while yet a child, and had begun life in the then newly settled region of the upper Hudson as a journeyman cabinet-maker. Having by diligence and economy accumulated a small capital, he commenced on his own account in 1822, the manufacture of furniture in Saratoga Springs, and a few years later was able to fit up the large and well equipped shop referred to, which stood on the site of the present Grand Hotel.

Ransom Cook

AGED 83 YEARS AND 7 MONTHS.

[*From a Photograph made in 1877, by W. H. Baker, of Saratoga, N. Y.*]

Cook was a characteristic type of that self-educated, intelligent, ingenious, and enterprising class of American mechanics, the products of whose industrial skill have become known and esteemed in every country of the civilized world. From his very boyhood, every moment that could be spared from toil was utilized to the utmost in increasing the small store of knowledge with which a common school education had furnished him, and books, not only of the natural sciences, but of history, law and politics, were his unceasing recreation and delight. A man of scrupulous integrity, diligent and successful in business, cordially detesting every form of chicanery and hypocrisy, yet ever ready with hand and purse to aid the needy and deserving; distinguished no less for his sound judgment than for his self-reliance and independence, he was one who could not but occupy a leading position in any community in which his lot was cast. Touched with the narrative of Davenport's struggles and misfortunes, not only did Cook hasten to relieve his immediate pecuniary necessities, but instinctively perceiving the future possibilities of his invention, he suspended the lucrative business which he was carrying on, that he might throw himself heart and hand into the new enterprise. Writing of this period Davenport says :—

> My mind was now measurably relieved, and I felt that I could apply myself to the object in view, with renewed diligence. As the patent had not been obtained, we commenced building a model for the Patent Office. Mr. Cook seemed to be more and more enamored with the invention as the work progressed. Several hands were now employed in constructing models, and important alterations in the arrangement of the machine were made by Mr. Cook, which seemed to increase his confidence in the ultimate successful application of the power. As soon as we had completed a model for the Patent Office, I proceeded to Washington and deposited my model and papers. A great variety of experiments were made in Mr. Cook's shop, with regard to the best mode of constructing both steel and electro-magnets, and many models of various sizes were completed.

At least two of the working models constructed by Davenport and Cook during the winter of 1836-7 are fortunately still in existence in an excellent state of preservation. The writer has had an opportunity of making a careful examination of one of these, a small electric locomotive running on a circular railway 24 inches in diameter, an illustration of which is given herewith. The motor proper consists of two straight electro-magnets, one constituting a stationary field, and the other an armature revolving in a horizontal plane parallel to and above the field. The armature is connected with the driving wheels by a speed-reducing bevel-gear. The field and armature magnets are each 5½ in. long, with cores ¾ in. in diameter. They are each wound with two No. 16 copper wires connected in parallel, there being 24 convolutions of each wire on each core. The commutator is constructed with insulated springs rubbing upon insulated metallic segments. The connections with the battery are formed by mercury-cups. Perhaps the most remarkable circumstance about this motor is that the field and armature are connected in parallel, so that in this model we have a veritable example of a *shunt-wound motor*, built in 1836-7. The workmanship of the little machine is of the finest description, and would reflect no discredit upon the shop of any leading manufacturer of to-day. It bears in every feature the impress of the unusual mechanical skill of its designer. This model of the circular railway, together with several stationary motors embodying the same general principles, were intended for exhibition in the city of New York. Near the close of the year 1836, Davenport, who was impatiently awaiting the issue of his patent, received a letter from Congressman Slade, conveying the unwelcome intelligence that his model and all the papers relating to his application had been destroyed in the fire which consumed the contents of the patent office. Not a paper nor a single one of the 7,000 models contained in the hall escaped destruction.

This disaster occurred on the 15th of December, 1836. Another model was immediately constructed and a new set of papers prepared, and about the middle of January, 1837, Davenport, supplied with funds by Cook, set out on his third journey to Washington, and filed an application on January 24, 1837, for his patent, which was issued in due course on the 25th of February following.

The following extract from the columns of a local journal will serve to show the stage which the invention had now reached :

> [*From the Saratoga Sentinel*, *Jan.* 3, 1837.]
>
> DAVENPORT AND COOK'S ELECTRO-MAGNETIC ENGINE.
>
> In company with Dr. Steel and several other gentlemen, we called upon Messrs. Davenport and Cook, of this village, on Saturday, with a view of examining the electro-magnetic engine invented by the senior partner.
>
> The ingenuity, yet simplicity of its construction, the rapidity of its motion, together with the grandeur of the thought that we are witnessing the operation of machinery propelled by that subtle and all pervading principle—electricity, combine to render it the most interesting exhibition we have ever witnessed.
>
> Although we shall say something on the subject, it is perhaps impossible to describe this machine by words alone, so as to give more than a faint idea of it to the reader.
>
> It consists of a stationary magnetic circle, formed of disconnected segments. These segments are permanently charged magnets, the repelling poles of which are placed contiguous to each other. Within the circle stands the motive wheel, having the projecting galvanic magnets, which revolve as near the circle as they can be brought without actual contact. The galvanic magnets are charged by a battery, and when so charged, magnetic attraction and repulsion are brought into requisition in giving motion to the wheel—the poles of the galvanic magnets being charged more than a thousand times per minute. . . .
>
> We were shown a model in which the motive wheel was 5½ inches diameter, which elevated a weight of twelve pounds. And to [illegible] the facilities for increasing the power of this engine, another model was exhibited to us with a motive wheel of eleven inches in diameter, which elevated a weight of eighty-eight pounds. Although these models have been for some time in progress, and we have occasionally been permitted to examine them, we have waited till the present period, when the practicability of obtaining a rapid and unlimited increase of power seems to be placed beyond a doubt, before expressing an opinion, or calling the public attention to the subject.
>
> If this engine answers the expectations of the inventor (and we believe no one can assign a reason why it should not), it is destined to produce the greatest revolution in the commercial and mechanical interests which the world has ever witnessed.

While Davenport was in Washington attending to the issue of his patent, Cook formed in New York the acquaintance of a typical representative of a class of people who have become in later years much more widely than favorably known in electrical circles as "promoters." This person, whose prominent position as secretary of one of the leading scientific and technical institutions in New York apparently entitled him to confidence, suggested the advisability of forming a joint-stock association to exploit the patent. To this Cook, and Davenport, after his return from Washington, willingly acceded, the more so, that they had found that the cost of procuring patents in the different countries of Europe, and of building a machine large enough to give the public convincing proof of the value of the discovery, would be likely to be considerably beyond their individual resources. In accordance with this plan, early in March articles of association were drawn up, by the terms of which a portion of the stock was placed in the hands of the promoter to enable him to raise funds "for building models and machinery, and for testing the utility of said invention; for giving to the same its greatest possible value for the benefit of the stockholders (the constructions so made to belong to the association); also for securing the exclusive use of said invention in Europe for the benefit of the association."

A supplementary agreement was executed at the same time, by which the promoter pledged himself to pay Davenport and Cook $12,000 in cash within thirty days. This was a large sum of money in those days, and the struggling inventor at last felt able to congratulate himself that his pecuniary troubles at least were at an end.

Every prospect seemed as favorable as could be desired or hoped for. As a curiosity we give a fac-simile of one the certificates of scrip of this—perhaps the first joint stock company ever organized to exploit an electrical invention.

In March, Davenport received a letter from Professor Benjamin Silliman, of New Haven, requesting information about his machine for publication in the *American Journal of Science* and adding:

> I have no doubt you will always receive advantage from the sound and judicious advice of our friend Mr.——— (the promotor) whose experience in business and great zeal and fidelity in this affair will no doubt greatly aid in all the proper business part of your concern.

The publication in Silliman's Journal of April, 1837, of a detailed description from personal examination of two different forms of Davenport's machine, one having revolving electro-magnets in conjunction with fixed permanent field magnets, and the other composed entirely of electro-magnets both in its fixed and revolving members, excited very great interest in scientific circles both in this country and abroad. At the end of the article, which is signed with the initials of Professor Silliman, the author sums up his conclusions in reference to the invention as follows :

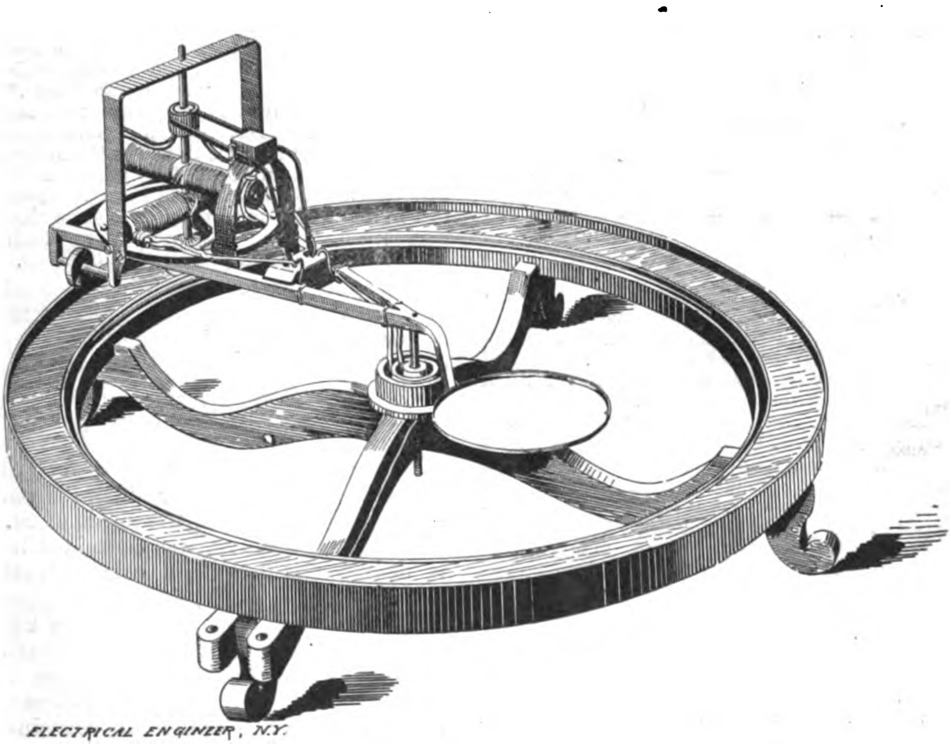
> 1. It appears then, from the facts stated above, that electro-magnetism is quite adequate to the generation of rotary motion.
>
> 2. That it is not necessary to employ permanent magnets in any part of the construction, and that electro-magnets are far preferable, not only for the moving, but for the stationary parts of the machine.
>
> 3. That the power generated by electro-magnetism may be indefinitely prolonged, since, for exhausted acids and corroded metals, fresh acids and batteries, kept always in readiness, may be substituted, even without stopping the movement.
>
> 4. That the power may be increased beyond any limit hitherto attained, and probably beyond any which can be with certainty assigned—since, by increasing all the members of the apparatus, due reference being had to the relative proportionate weight, size, and form of the fixed and movable parts—to the length of the insulated wires and the manner of winding them—and to the proper size and construction of the battery, as well as to the nature and strength of the acid or other exciting agent, and the manner of connecting the battery with the machine, it would appear certain, that the power must be increased in some ratio which experience must ascertain.
>
> 5. As electro-magnetism has been experimentally proved to be sufficient to raise and sustain several thousands of pounds, no reason can be discovered why—when the acting surfaces are, by skillful mechanism, brought as near as possible, without contact—the continued exertion of the power should not generate a continued rotary movement, of a degree of energy, inferior indeed to that exerted in actual contact, but still nearly appoximating to it.
>
> 6. As the power can be generated cheaply and certainly—as it can be continued indefinitely—as it has been very greatly increased by very simple means—as we have no knowledge of its limit, and may therefore presume on an indefinite augmentation of its energy, it is much to be desired, that the investigation should be prosecuted with zeal, aided by correct scientific knowledge, by mechanical skill, and by ample funds. It may therefore be reasonably hoped, that science and art, the handmaids of discovery, will both receive from this interesting research a liberal reward.
>
> Science has thus, most unexpectedly, placed in our hands a new power of great but unknown energy.
>
> It does not evoke the winds from their caverns; nor give wings to water by the urgency of heat; nor drive to exhaustion muscular power of animals; nor operate by complicated mechanism; nor accumulate hydraulic force by daming the vexed torrents; nor summon any other form of gravitating force; but, by the simplest means—the mere contact of metallic surfaces of small extent, with feeble chemical agents, a power everywhere diffused through nature, but generally concealed from our senses—is mysteriously evolved, and by circulation in insulated wires it is still more mysteriously augmented, a thousand and a thousand fold, until it breaks forth with incredible energy; there is no appreciable interval between its first evolution and its full maturity, and the infant starts up a giant.
>
> Nothing since the discovery of gravitation and of the structure of the celestial systems, is so wonderful as the power evolved by galvanism; whether we contemplate it in the muscular convulsions of animals, the chemical decompositions, the solar brightness of the galvanic light, the dissipating consuming heat,

and more than all, in the magnetic energy, which leaves far behind all previous artificial accumulations of this power, and reveals, as there is full reason to believe, the grand secret of terrestrial magnetism itself.

We shall hereafter give an accurate drawing, made to scale, of one of three or four machines, substantially alike, which were constructed in the winter of 1836-37, by Davenport and Cook. The model in the patent office in Washington was one of these, another was sent to Europe to be used in obtaining patents in various countries, and at least one other was kept on exhibition in New York, where it was inspected by crowds of curious spectators.

The workshop and laboratory of Davenport and Cook were in a large building at 42 Stanton street, which has long since disappeared and been replaced by tenement houses. Writing of this period, Davenport says:

> During the spring and summer of 1837, our laboratory, which was a spacious one, was crowded to overflowing daily by visitors to examine the variety of machines and apparatus which were on hand, and in progress of construction. Among the distinguished and scientific gentlemen who visited our work, were Professor Samuel F. B. Morse, then of the New York University, and Doctor Charles G. Page, then of Boston. Professor Morse frequently mentioned his intentions of experimenting on the electro-magnet for the purpose of producing signs for signals for telegraphic purposes, and stated that he had long ago conceived the idea of transmitting intelligence by electricity.[1] A gentleman from Germany, Baron D——, purchased secretly from one of our workmen drawings of some of the best models, and in about six months from that time the German papers were teeming with the news that Baron D—— had invented a new motive power, a model of a machine, put in motion by electro-magnetism! The German Diet is said to have voted this *gentleman pirate* 200,000 francs, or $40,000, as a compensation for his wonderful invention.[2] In the course of this summer we constructed a great variety of machines, testing the power of each to ascertain the amount of improvement, and among these was a miniature locomotive engine which moved on a circular railway of 14 feet in diameter, moving a train of half-a-dozen cars. Many of the public prints came out in favor of the invention, recommending that capitalists should examine the operation of the machines, and aid in the enterprise by their assistance in furnishing funds.


ELECTRICAL ENGINEER, N.Y.

MODEL OF ELECTRIC CIRCULAR RAILWAY MADE BY DAVENPORT AND COOK IN 1836-7.

[*From recent photograph and sketch by F. L. Pope.*]

Many of these newspaper notices are so characteristic, that I cannot forbear making a few extracts from them:

(*From the New York Herald, April* 27, 1837.)

A REVOLUTION IN PHILOSOPHY.—DAWN OF A NEW CIVILIZATION.

> We mentioned slightly the other day a few particulars descriptive of the electro-magnetic machine now preparing for exhibition in this city. We shall now go a little deeper into this most extraordinary discovery, probably the greatest of ancient and modern times, the greatest the world has ever seen, the greatest the world will ever see. . . . .
>
> We are in the commencement of a revolution in philosophy, science, art, and civilization. The occult and mysterious principle of galvanism is now beginning to be developed in all its magnificence and energy. . . . .
>
> It is utterly impossible to give vent to all those burning thoughts which crowd upon our mind at the contemplation of this discovery. It surpasses any discovery of ancient or modern times. The generalization of this principle, and its undoubted identification with all the phenomena of nature—with motion—with animal life—with earthquakes—with gravity—with electricity—with the motion of the earth and planets round the sun, must and will create an entire revolution in all science, in all art, in all philosophy, and in all future civilization. Indeed we may go further, and however droll it may appear, we have strong suspicions that the friendship, esteem and the mysterious love between the sexes is founded on the same principle with which Mr. Davenport turns his wheel, and the lightning flashes from heaven—and the aurora borealis spreads out its garments of rosy light in the sky—and the very planets themselves run their races round the sun from eternity to eternity.
>
> Enough for the present. We have long been a student in chemistry, electricity, galvanism, and such like sciences. We shall illustrate our views at our leisure. Meantime we bid all prepare for an organic revolution in science, philosophy, religion, and civilization. We are just entering upon a wonderful age.

(*From the N. Y. Evening Star, August*, 1837.)

> In concurrence, unanimously we believe, with all who have

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[1] From the sworn deposition of Professor Leonard D. Gale, corroborated by others, printed in the record of the Supreme Court in the case of *O'Reilly* v. *Morse*, it appears that the first crude model of Morse's telegraphic recording apparatus was constructed by him in the late fall of 1835, and that Gale became associated with him in 1836. In his deposition Gale says:—"From April to September, 1837, Professor Morse and myself were engaged together in the work of *preparing magnets*, winding wire, constructing batteries, etc., in the University, for an experiment on a larger but still very limited scale, in the little leisure that each had to spare. . . . The latter part of August, 1837, the operation of the instrument was shown to numerous visitors to the University." It must have been while this work was going on, that Morse visited Davenport's laboratory. The marked likeness between the electro-magnet in the original instrument of Morse, preserved in the cabinet of the Western Union Telegraph Company, at 195 Broadway, New York, and the magnets in some of the motors of Davenport and Cook, constructed just before they brought their apparatus to New York, furnishes grounds for the belief that Morse's knowledge of the construction of Henry's magnet may, in part at least, have been derived from observations made during his visit to the laboratory here referred to.

[2] The writer, notwithstanding much research, has failed in his attempts to penetrate the incognito of the "gentleman pirate." The statement is given as it is written. Possibly others may be more successful.

witnessed the operations of this extraordinary and simple apparatus, and listened to the lucid and eloquent explanations of Mr. Cook, we confess our utter amazement at the prodigious changes which it manifestly foretells in the application of an entire new and immeasurable agent of mechanical power; and at the same time, while we see and admire, acknowledge ourselves, for want of language to sustain us, utterly incompetent to impart any correct conception of this marvelous invention to our readers. All we say is, "go and be convinced." . . . . . .

It is a sublime but not wild idea of Mr. Cook, that a ship's bottom, covered with suitable plates and the ocean for its bath, may drive herself along with incredible velocity, at the same time generating abundance of hydrogen to light her onward upon the deep. . . . .

But it is in a commercial view that it exhibits, in prospective at least, an importance combined with the finest sublimity. It is well known that sea-water forms an active bath for the galvanic battery when kept up by frequent changes. Is there any insurmountable objection to arranging the sheathing of the vessel so as to form a battery, and with the ocean for its bath and the application of magnetic power, "drive the ship onward in her course and guide her to the point of destination by the same agent?"

When the use of steam is proposed in conducting our distant commerce, we cannot avoid the reflection that on the vast deep the perils of wind and waves are sufficient without adding those of fire and explosion.

(*From the N. Y. Evening Post.*)

We learn that some recent improvements have been made in the application of electricity as a moving power to machinery. A larger apparatus than the one hitherto exhibited has been constructed under the direction of Mr. Cook, now in this city, which is to set in motion a turning lathe, in order that those who take an interest in the invention may see it at work. Nothing but the difficulty of the times now stands in the way of demonstrating the application of this power on a large scale to machinery of the most ponderous description.

(*From American Correspondence of London Morning Herald.*)

I did not write by the packet of the 16th [August, 1837], because I had made an appointment for the next day, to go and see the electric-magnetic machines of Mr. Davenport, and which I considered well worthy to be the subject of a letter, provided there were any grounds for the vast expectations founded upon them, not only by the inventor and his friends, but by every person who had examined them, and heard the explanations of Mr. Davenport. Having seen them, I am free to confess that I cannot discover any good reason why the power may not be obtained and employed in sufficient abundance for any machinery; why it should not supersede steam, to which it is infinitely preferable on the score of expense, safety, and simplicity. I do not very clearly understand the principle (something about changing the poles from positive to negative, or from north to south), and vice-versa, in rapid succession; but this is of little consequence, as I shall be able to send you, probably by the next packet, a pamphlet containing a full exposition, with illustrative engravings. Mr. Cook, who is associated with Mr. Davenport in the patent, is now engaged in preparing this pamphlet, and he has promised me the first copy that is printed. They have patented their invention in France and England. . . . .

The last machine constructed by Mr. Davenport occupies a surface of about 18 inches square, that is, 18 inches on each side, and consists merely of a platform, having upon it an iron circular frame, with an arch extending from side to side above it, a spindle in the centre playing in this arch at top and in a socket below, and on this spindle an incomplete wheel, formed of two cross pieces of iron, with segments of a circle at the four extremities. It is, in fact, a wheel, with four breaks in its periphery. Some hundreds of feet of isolated, or coated, copper wire are wound around the cross pieces, and also around the fixed circular frame; the connection with the galvanic batteries, which are three small cylinders, each consisting of six concentric tubes of zinc and copper, the outer one scarcely larger than a quart pot, is, formed by small rods of copper. The revolving wheel is six inches in diameter, and weighs about six pounds. Attached to the upright spindle is a small cog-wheel, which may be made to work in other wheels, with axles, for the purpose of showing how great a weight can be raised from the ground.

With the three batteries acting on it, the revolution of the wheel was 1,000 times in a minute; and these 1,000 revolutions raised a weight of 200 lbs. one foot. The first machine made by Mr. Davenport, which is much smaller and has but one battery, raised but 24 lbs. He is confident that with a number of batteries, or one very large one, say, as big as a barrel, there would be power enough to drive the largest machinery, while the cost of construction would be reduced to a fifth, or perhaps a tenth, and that of attendance, fuel, etc., now forming so heavy an item in the expenses of steam-power, would be almost done away with. Half a barrel of blue vitriol, and a hogshead or two of water, would send a ship from New York to Liverpool; and no accident could possibly happen, beyond the breaking of some part of the machinery, which is so simple, that any damage could be repaired in half a day. Surely it is a great and vastly important discovery, and the wildest imagination could hardly grasp the wonders in achieving which it may, and doubtless will, become the instrument.

A reference to the preceding description of the machine shown to the correspondent of the London *Herald*, is sufficient to show that it was quite an advanced type of motor, having a horseshoe field, and a four-pole armature fitted with segmental polar surfaces. A model of one of the machines of this type, but having two poles only, is still in existence.

Amid the general chorus of praise, there was, as might have been expected, now and then an inharmonious note, as witness the following communication:—

[*From the Journal of Commerce.*]

Messrs. Editors: I have been much gratified with your exposure of various humbugs of late in science and politics; but if I recollect right, you have not touched upon what I consider as also indubitably a great humbug. I mean Mr. Davenport's machine, so far as it boasts of being of any practical utility. I am aware that Mr. Silliman speaks of Mr. Davenport's invention as "putting into our hands a new power of great but unknown energy," and supposes the power may be increased beyond any limit which can be assigned; he therefore seems to speak of the discovery as of great pecuniary value, and recommends that the investigation should be prosecuted "by ample funds," etc. Mr. S. has not, however, shown in what way any great and useful power is to be attained by Mr. Davenport's invention, and probably he would not again lend his name in the same manner to this affair. I am aware also that Mr. D. is able by his machine to move a couple of tiny cars about a railroad in Barclay street, of a dozen or fifteen feet in diameter; but I propose to show that he cannot, by electro-magnetism, acquire any great and valuable power, and that his machine in its grand promise is a *humbug*.

Annoying caricatures were also circulated, a fashion much in vogue at that day. One of these skits represented a boat propelled by lightning; Davenport and Cook, with despair depicted upon their countenances were tinkering at the machinery, while Prof. Silliman, in an attitude of mock dignity, was expatiating to the public on the merits of the scheme.

So far as can be ascertained, the earliest account of the experiments of Professor Moritz Hermann von Jacobi, of Königsberg, Prussia, afterwards of St. Petersburg, which reached this country, was contained in a paper published in Sturgeon's *Annals*, translated from *Comptes Rendus.*[3] This admirable paper, which, considering the early date of its publication, displays a masterly knowledge of the fundamental principles of electro-magnetism, as well as an intimate experimental acquaintance with its phenomena, especially as exhibited in the actions and reactions of the magnets of an electric motor, contains a full description of Jacobi's machine, illustrated with an isometrical drawing which clearly exhibits the details of its construction. From this drawing, which we reproduce in fac-simile, it clearly appears that not only is its principle the same as that of Davenport and Smalley's motor heretofore described, but that even in the details of construction the differences are comparatively unimportant. In this paper, Jacobi states that he first succeeded in obtaining rotary motion in May, 1834, and incidentally refers to a paper partially describing it, which he read before the Academy of Sciences of Paris, on December 1, of the same year, an abstract of which was published in *l'Institut*, No. 82, on December 3rd. The following is a translation of this note:—

M. Jacobi, of Königsberg, presented to the Academy a paper on a magnetic engine of his invention, in which magnetism is employed as a motive power. The following is the description given of it:—The apparatus consists of two systems comprising eight bars each of soft iron, each 7 in. long and 1 in. in diameter. These two systems of bars are placed at right angles, and so arranged on two discs that the ends or poles of the bars are opposite one another. One disc is fixed while the other revolves on its axis, and the movable bars are thus made to pass as close as possible in front of the fixed ones. The 16 bars are wound with 320 feet of copper wire, ¼ inch in diameter, the ends of which were connected with a voltaic apparatus. The whole mass, moving at a speed of six feet per second, gives about 50 lbs., being a considerable *vis viva.* The work thus furnished, measured by an apparatus similar to the Prony brake, is equal to a weight of 10 or 12 lbs. lifted one foot per second. This success is principally due to a novel construction of the commutator by which the changes of polarity are worked. These take place eight times in each complete revolution; that is to say, eight times in half or three-quarters of a second, the ordinary speed of the machine, when the water in the cell is so little acidulated that the development of gas is hardly appreciable.

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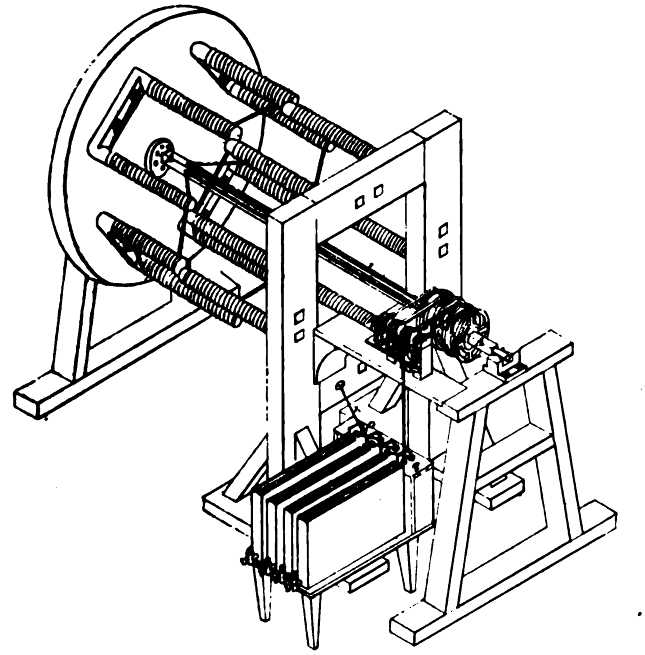
[3] Sturgeon's *Annals of Electricity*, etc., i., 408.

In 1838, under the patronage and at the expense of the Emperor Nicholas, of Russia, Jacobi constructed a much larger motor upon substantially the same principles, with which he succeeded in propelling a boat upon the Neva, at St. Petersburg. As full accounts of this experiment have been many times published, I will not occupy space by repeating them here. The illustration given will suffice to show the general character of the motor used on this occasion.

The question of actual priority, in point of time, as between the invention of Davenport and that of Jacobi is a very close one. If the rotary motion which Jacobi obtained in May, 1834, was effected by the identical apparatus described in his paper read before the Academy in November of that year, then his priority must be conceded, but it does not appear to be certain that such is the case. In any event, the discoveries here and abroad must necessarily have been wholly independent, although nearly coincident in point of time, and it is, to say the least, remarkable, that one who labored under such limitations and disadvantages as Davenport, should by the unaided force of his native genius, have achieved a result which has been universally conceded to reflect the highest credit upon the talents and perseverance of one of the most able and learned experimental philosophers of his day.



JACOBI'S ELECTRO-MAGNETIC ENGINE OF 1834.

[*Reproduced from Sturgeon's Annals.*]

The following letter, written near the close of the year 1837, gives an interesting résumé of the progress of affairs in the laboratory at that date[4]:

[*Thomas Davenport to Professor Benjamin Silliman.*]

Dear Sir:—Having lately made a number of applications of the power of large galvanic magnets in propelling machinery (being independent of the large machine now constructing by the association*), I have thought proper to state to you the results, believing they would not be uninteresting to you.

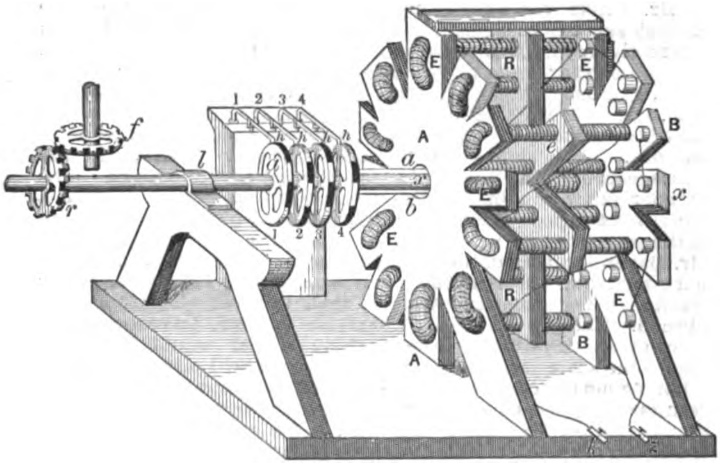
I have constructed a machine with two revolving magnets 2 feet in length, made of iron, 3½ inches in diameter, and weighing, after being wound with 6 coils of No. 10 copper wire, 100 pounds each. Three stationary magnets of 2 feet diameter, were placed around the periphery, making 6 poles and weighing 100 pounds each.

With this machine I have produced 100 revolutions per minute with 6 square feet of sheet zinc exposed to action, surrounded with thin sheet copper.

I then displaced the stationary magnets, and substituted one magnet 8 inches in diameter, forming a semi-circle, with the poles directly opposite each other, and weighing about 100 pounds. With this magnet I produced 150 revolutions per minute, using the same quantity of zinc surface. With one revolving magnet I produced 175 revolutions per minute, with 4 square feet of sheet zinc. I next constructed a hollow magnet 2 feet in length and 4 inches in diameter, made of boiler iron, 5/16 of an inch in thickness, with 4 coils of copper wire, with which I succeeded in getting 100 revolutions per minute. A hollow magnet was then constructed of thin sheet-iron, of the thickness of common stove-pipe iron. which revolved 150 times per minute. Hollow magnets I think may be used to great advantage where weight is an objection; but in my experiments I generally make use of solid iron.

I also constructed a machine with simply two magnets formed of 2-inch round iron, 15 inches in length, of the stirrup form. The distance between the centres of the poles is 5 inches and the magnet revolves 450 times per minute, with 2 square feet of zinc. The stationary magnets being placed with the poles of the revolving magnet pointing downwards, the shaft to which the revolving magnet is attached passes through its centre and rests on the centre of the stationary magnet. Two of these machines (weighing in all 50 pounds) I have attached to small drilling works, which I find produce sufficient power to do all my drilling of iron and steel, to the size of ¼ of an inch in diameter.

I have adopted this form on the third machine which I have recently put in operation. The magnets are formed of 2¾ inch iron, with the centres of their poles 9 inches apart and weighing 50 pounds each; with this I produced 300 revolutions per minute, and have successfully applied it to turning hard wood of 3 inches diameter. I find the power increases in full proportion to the increase of weight and without increasing in proportion the size of the battery. The wire must be increased in size in proportion to the size of the iron used, and, consequently, the difficulty attending long wires will always be avoided.



MOTOR USED BY JACOBI IN HIS EXPERIMENT ON THE NEVA IN 1838.

[*By permission of D. Van Nostrand Co.*]

I find no difficulty in using my machine 12 hours in succession, without changing batteries or agitating the solution.

I am erecting conveniences to test the powers of each magnet as they are increased in weight and size, and think I shall be able in season for the April number of your journal to give the exact increase of power in proportion to weight, of magnets weighing from 10 pounds to several tons.

I have also made some very satisfactory trials, while making my machines, respecting the expense for the consumption of zinc and acids, and I think I shall soon be able to give nearly the precise cost of making the largest machinery.

Galvanism is, I trust, destined to produce the greatest results in the most simple form, and I hope not to be considered an enthusiast, when I venture to predict, that soon engines capable of propelling the largest machinery will be produced by the simple action of two galvanic magnets, and worked with much less expense than steam. Yours respectfully,

New York, Dec. 26, 1837. THOMAS DAVENPORT.

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[4] Silliman's *Amer. Jour. Sci.*, xxxiii. (appendix).

* The machine alluded to in the above letter, as now being constructed for the Electro-Magnetic Association, by Messrs. Davenport and Cook, is nearly completed, and is expected to be of about two tons' power. It is formed by a combination of small magnets, weighing about four pounds each, and three-and-a-half inches between the poles. These magnets are placed—two hundred and thirty-four in number, on an iron shaft six feet in length, and a corresponding number in a circle as stationary magnets.

In 1838, Frederic Coombs was sent abroad to obtain patents in Great Britain and other countries, and to exhibit the invention with the hope of enlisting foreign capital in aid of the enterprise. The following notice was published in the proceedings of the London Electrical Society, of its meeting of July 17, 1838:[5]

> Previous to the chair being taken, Mr. Coombs, of New York, exhibited to the members a locomotive engine propelled by electro-magnetism. This machine, which is at present exhibiting at the Royal Gallery of Practical Science, consist: 1st. Of the carriage containing the apparatus, but which, in consequence of the arrangements necessary to the taking out of a patent in this country not being completed, could not be explained. 2d. Two voltaic batteries; these are made on the principle of Hare's calorimotor, excited with a strong solution of sulphate of copper. 3d. Two carriages attached to the apparatus. The apparatus, batteries, and carriages weigh 60 or 70 lbs., and are placed on a circular railroad. Upon connexion of the apparatus being completed (by means of four cups containing mercury) with the poles of the two batteries, the apparatus is set in motion and revolves for some time with considerable velocity, but which decreases as the action of the battery diminishes.

The exhibition appears to have been favorably received by the members present, but it does not appear that anything further was accomplished. The following is selected from a number of newspaper notices:

[*From the London Morning Herald, August*, 1838.]

DAVENPORT'S ELECTRO-MAGNETIC RAILWAY LOCOMOTIVE.

> Mr. Davenport has at length gratified the curiosity of the English skeptics to a certain extent, by sending over a model of a locomotive engine, which is now exhibiting at the Adelaide Gallery, in the Lowther Arcade, worked on the same principle as his larger stationary engines. This carriage runs on a circular railway, and draws after it two other carriages, which move, by the aid of two small galvanic batteries, at the rate of about three miles an hour. The weight thus propelled is nearly 80 lbs., and the carriage containing the apparatus about one foot square. The manner in which the electro-magnets are arranged is kept a secret for the present; but the principle on which the application of the power depends is well known, and the chief superiority in Mr. Davenport's invention consists in his having, by some peculiar contrivance, brought into exercise a greater amount of power within a given space and weight, than has been hitherto accomplished. Though we do not anticipate that Mr. Davenport's invention as exhibited in the working model would be found applicable on a large scale with any practical advantage; yet what he has accomplished is sufficient to show that important results may be expected from future improvements in the application of the same principle. We are informed by an American gentleman who has recently arrived in England that he witnessed a two horse power electro-magnetic engine, of Mr. Davenport's construction, employed in printing a newspaper in New York, and that it performed the work most satisfactorily. Whether or not, however, this was done at a cheaper rate than the same power might be obtained from steam, we are not able to ascertain.

Frederic Coombs, the exhibitor of the Davenport motor in England, in his old age became mentally unbalanced, and from his harmless eccentricities of dress and behavior was, for many years, a well known character in the streets of Washington, San Francisco and New York. His personal appearance was remarkable, combining as it were, the stately dignity of a Washington with the affable and condescending benevolence of a Franklin. The portrait given herewith will be recognized by many of our older readers.

The peculiar business methods pursued by the individual who had been entrusted with the management of the financial interests of the association soon came to be of a character to excite the suspicions both of his associates and of the public. His plan appears to have been a sufficiently simple one, namely, to sell shares to any one who could be induced to purchase, at any price the party could be induced to pay, and to put the proceeds in his own pocket, at the same time persistently refusing to render to his associates any account of his doings, but reluctantly disgorging, from time to time, such sums of money as were absolutely necessary to keep the laboratory going with the smallest possible number of employés. This course of conduct could have but one result. The confidence of the public generally in the integrity of the management of the association became impaired, while those who had purchased shares not unnaturally began to entertain suspicions that they had been duped. Ransom Cook was a man who was not only peculiarly sensitive in matters of honor, but one who was utterly without patience with fraud or chicanery in any form. He did not hesitate to express his disappointment and vexation at the conduct of the business manager, and ultimately, on the 12th of February, 1838, he sold nearly the whole of his interest for a mere pittance, withdrew in disgust from the enterprise, and returned to his home in Saratoga. During the year they had carried on operations in New York, Cook had expended on the work some $3,000, and Davenport more than $2,000 of their own money, while the total amount received from their business manager, instead of the promised $12,000, was only $1,700. After the departure of Cook, Davenport and M. W. Nelson, the party who had purchased Cook's interest, brought a suit in chancery against their unprincipled associate, the result of which was that the court compelled the latter, much against his will, to exhibit his books and render an account of his stewardship. Davenport had meantime sold a part of the patent right for the New England States which he had reserved to himself, and the proceeds furnished him with means to continue his experiments for a time without other aid.

One cannot but deplore the unfortunate occurrences which led to the permanent withdrawal of such a man as Ransom Cook from further association with a department of experimental research, in which his natural tastes, no less than his remarkable talents, so eminently qualified him to achieve distinction. An artificer of surpassing skill; a diligent and observant student of nature's ways and works; an original thinker, and an inventor of a high order; the brief story of a single one of Cook's mechanical conceptions will portray more vividly than volumes of description the rare genius of the man. Ever full of intelligent curiosity regarding the cunning works of nature, he became at one time absorbed in the study of the structure and habits of the so-called "ship-worm" (*teredo navalis*). More than anything else, he was struck with the capacity of this little creature to apply its cutting tool with equal facility and efficacy, at any angle to the grain of the wood, and as a skilled wood-wooker, his mind at once seized upon and sought to apply the hint which nature had thus given. Patiently and skillfully, with his own hands, he forged from steel experimental augers and bits, with cutters modeled from the teredo's mandibles, until at last the result was achieved; the curved tips of the justly celebrated "Cook bit," an implement which by sheer intrinsic merit has made itself indispensable to the "kit" of every woodworker in the civilized world. Of his many other scarcely less ingenious and original conceptions, space forbids even a passing notice here. In the autumn of his days, retiring with a handsome and well-earned competency from the active pursuits of life, he provided himself with a well-stocked library, and a model laboratory equipped with the most improved mechanical appliances and scientific apparatus. Here it was his especial delight to entertain his chosen friends, among whom were numbered many of the most prominent of public men and scientists who were his contemporaries. He died at Saratoga Springs, N. Y., May 26, 1881, at the advanced age of 87. It is impossible to resist the conviction, that had Ransom Cook continued to devote his unusual and peculiar talents to the industrial development of electro-magnetism, many of those knotty problems, which for so many years confronted and obstructed the pathway of the investigator, would have received at his hands an earlier solution.

Thrown once more upon his own resources, Davenport proceeded to build several larger machines, of a type very similar to that of the model locomotive in the illustration on page 67, referring to which he says:

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[5] Sturgeon's *Annals of Electricity*, etc., iii. 156.

I increased the size of my magnets to about 50 lbs. each, and with four machines, with two of these magnets in each, I moved a large Napier printing press in the month of April, 1838. There was not, however, sufficient power for printing papers, although the machine would keep the press in motion.

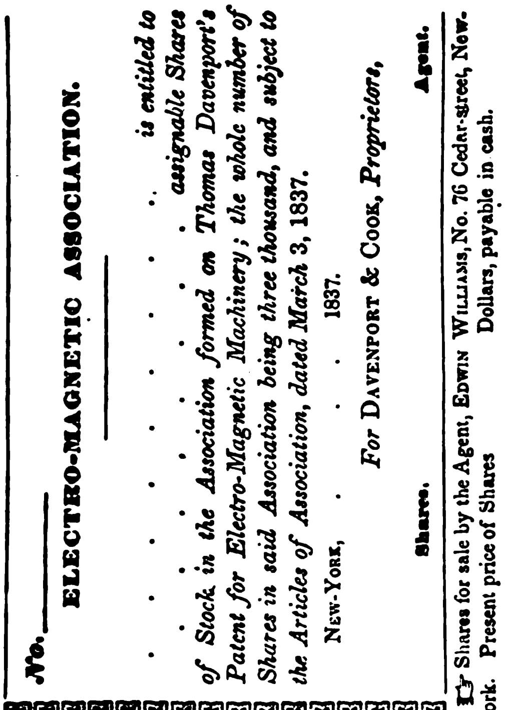
While engaged in these experiments, he received a letter from Dr. Charles G. Page, then of Boston, who had been for some time engaged in exploring the same field. It is of interest as showing the views of Page at that date, and especially in view of the reference to the experiment of arresting the rotation of a magnetic bar by what is obviously an inductive action:

[*Charles G. Page to Thomas Davenport.*]

BOSTON, April 28th, 1838.

THOMAS DAVENPORT, ESQ.,

Sir:—I have for a long time (as is well known to you) been pursuing the same experiment as yourself, but for many months past, I believe I have been on an entirely new and different track. My main object has been to prevent retardation or back action. My plan is to cut off the galvanic current from both systems of magnets instead of changing poles as they arrive at equilibrium. The advantage of this I have fully tested, and my model for a patent went to the office three months ago. I have had notice from the Commissioner that it should be attended to as soon as practicable, but the certificate has not yet arrived. This experiment has been tried on a large scale, and has failed, not because of any fault in the plan, but for the simple reason that the magnets were too much crowded. I made a demand on the company for $500, to alter the machine, but as they have already exceeded their subscription by $500, they thought best to give it up. But I have no idea of abandoning the experiment myself, as I have full confidence that a power equivalent to that of one or two men can be obtained with economy. I have a foundation for this calculation, and can prove by some recent discoveries I have made that in the present state of our knowledge, the economy of the power is limited somewhere about the strength of a single man. I have made a still further improvement, which was fairly tested in a machine completed yesterday, by which I can increase the power of a machine to a great extent without increasing the battery. I also made some time since certain important discoveries in magnetic electricity, which throw a vast deal of light on this subject. I showed one of them yesterday to Mr. Horn, in a new machine which works exceedingly well without change of poles. To his great surprise I stopped almost instantly a bar making a thousand revolutions [per minute] by bringing together the two ends of a wire which had no connection with the battery, nor with the wires around the magnet. This is a most singular thing, as the wire is entirely independent, and the machine stops much more suddenly than by reversing poles.



No. ——

ELECTRO-MAGNETIC ASSOCIATION.

. . . . *is entitled to*
. . . . *assignable Shares*
of Stock in the Association formed on Thomas Davenport's
Patent for Electro-Magnetic Machinery; the whole number of
Shares in said Association being three thousand, and subject to
the Articles of Association, dated March 3, 1837.

NEW-YORK, . . 1837.

For DAVENPORT & COOK, *Proprietors,*

Shares. Agent.

☞ Shares for sale by the Agent, EDWIN WILLIAMS, No. 76 Cedar-street, New-York. Present price of Shares Dollars, payable in cash.

STOCK CERTIFICATE OF ELECTRO-MAGNETIC ASSOCIATION.

[*Fac-Simile of Original in possession of W. G. Davenport.*]

I have still more recently made a more important discovery than this last. It does not relate at all to change of poles or cutting off the current, but is simply a method of increasing the power of the magnet. I will engage to make any machine of yours in five minutes time half as strong again, or forfeit the value of the machine (the battery shall remain the same). I feel very sure the power will be useful to the extent I have above named, but for reasons which I can make conclusive to any one I do not believe in its *indefinite* increase.

FREDERIC COOMBS.

[*From a photograph in the possession of Stephen D. Field.*]

I am now under obligations to no one here, and before I get up another interest I should like to know your views. I believe it would be for your advantage and mine, and contribute much to the success of the experiment, if our interests should be united. If you will make me a reasonable offer, I will take hold with you heart and hand, and there is no question but that in a short time we could make an excellent business of it, as we could cover the whole ground. Please write me immediately.

Respectfully yours,
CHARLES G. PAGE.

Acknowledging the receipt of this letter, Davenport replied briefly on Nov. 2, stating that he was "not in a situation to make or receive propositions relative to a union of interests," inasmuch as the ownership of his invention was largely vested in the corporation which had been organized to exploit it.

HOW TO DISPOSE OF THE INDIANS.

Secretary of War Proctor's mail is burdened with letters from cranks making suggestions as to the conduct of the Indian campaign. One correspondent proposes to exterminate the entire Sioux nation or a large part of it by establishing an electric plant at Pine Ridge and stretching a wire around the hostile camp. Then, turning on the current, the Indians are to be driven down to the wire, which is to be drawn closer and closer until contact with the wire causes wholesale destruction.

CURRIE'S NEW STORAGE BATTERY PLATE.

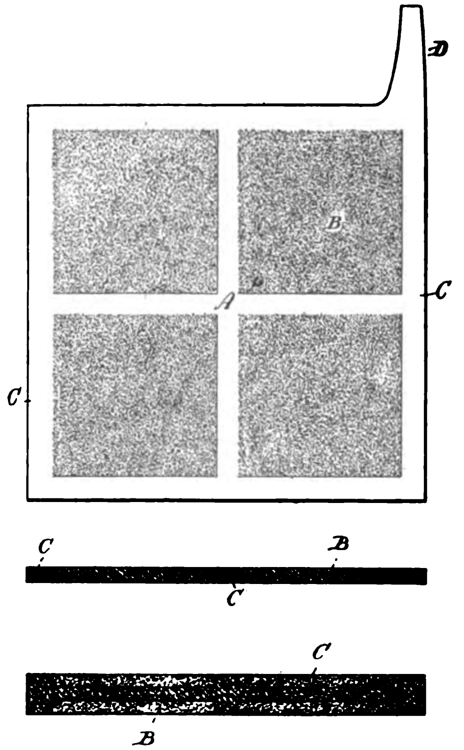
Our readers who are already acquainted with the work of Mr. Stanley C. C. Currie, electrician of the United Electric Improvement Co., of Philadelphia, will be interested in a new form storage battery plate recently patented by the same gentleman.

Mr. Currie's principal objects have been, first to dispense with the employment of separate frames, central supports, etc., for supporting the active material, and, second, to provide an inexpensive and durable means for supporting the active material as an integral part of the plate.

This is accomplished by pressing the plate at the edges, which are thus rendered compact. The accompanying engraving, Fig. 1, shows such a plate before, and Fig. 2, after the compression has been effected, Fig. 3 being a transverse section of the plate. As will be seen, the dense portions c are arranged around the periphery and parallel to the sides.

The method of making the plate is very simple. For this purpose a compound of lead—for example, chloride of lead or chloride of lead and zinc are melted together and then cast in molds so as to form the enlarged portions as well as the lug; the cast mass is then reduced by chemical or electrolytic action, or both, to a porous metallic state. The porous plates having enlarged parts are then placed between dies which compress and render the enlarged portions dense without in any way affecting the other portions of the plate.

After the enlarged portions of the plate together with the lug D are sufficiently compressed, the latter may be readily fitted for use as a binding-post in the usual manner.



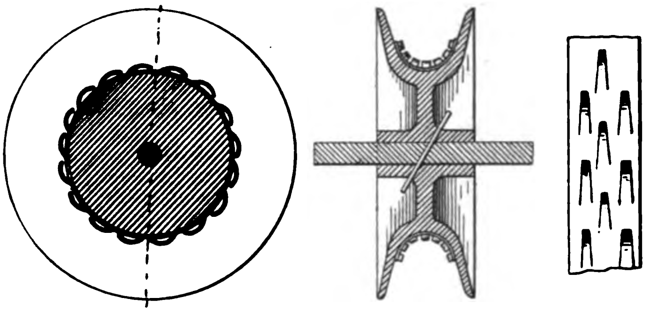
Figs. 1, 2 and 3.—Currie's Storage Battery Plate.

The portions of the plates which are compressed are rendered tough and dense, and as a consequence not only firmly support the active material, but also afford an efficient electrical connection between the conductors and the active material.

Iowa City, Ia.—The object of the suit of C. H. B. Carter *vs.* Iowa City Gas Light Co. is to have the affairs of the company placed in the hands of a receiver, as the property is liable to go to pieces through the conflict of interests.

LIEB'S ELASTIC TROLLEY WHEEL.

The operation of electric railways has developed the fact that while the trolley wheel is a most simple device for taking off the current from the overhead conductor, it labors under the disadvantage of affording only a small surface contact for the passage of the current, being reduced, in fact, to a mere tangent point. As a result, the resistance of the contact entails a loss of energy and at the same time causes a decided heating of the trolley wheel, which, in consequence, requires copious lubrication to keep it in good running order. Again, the solid trolley wheel at present employed has a tendency to jump, causing sparking, as well as noise and wear.



Figs. 1, 2 and 3.—Lieb's Elastic Railway Trolley.

In order to obviate all these difficulties and to secure better and more uniform contact between trolley and trolley wheel, Mr. Ch. H. Lieb, of this city, has designed an elastic trolley wheel, one form of which is illustrated in the accompanying engravings. As will be noted, the wheel is provided with a lining of brass in which springs are cut and curved outwards away from the plane of the sheet and having their ends curved inward again, as seen in Fig. 1, so that they cannot catch and be turned back by the trolley-wire when running in either direction.

It is obvious that the pressure of the trolley-wire on the springs compresses them so that there is relatively no shock or jar of the trolley against the wire, and separation of them is largely avoided; the shock of the trolley, also, when it comes in contact with the clamps by which the trolley-wire is suspended, is largely avoided. Thus the movement of the trolley along the trolley-wire is smooth and even, and sparking, wear on the parts, and noise are largely reduced.

It will also be observed that whereas in the usual form the trolley-wire comes in contact with only a very small arc of the trolley-wheel and at one point through which the contact must be made, in the new construction the flattening or compressing of the yielding surface of the wheel upon pressure by the wire or its attachments greatly enlarges the area of contact and also affords a number of points of contact, one or more of which at all times affords electrical connection, the effect being the same as though a series of trolley-wheels were used to make the same electrical connection.

A "LOST CHILD" TELEPHONE SERVICE.

The Missouri and Kansas Telephone Company is considering the matter of introducing what might be termed a "lost child service." It was originated in Indianapolis by G. J. A. Halford, now of the Youngstown, O., *Telegram*, a brother of Elijah Halford, President Harrison's private secretary. As soon as a child was lost the information would be telephoned to the central station. When a lost child was found this also would be telephoned. The finding would then be telephoned to the number that reported the losing. In some cases the child has been restored to its mother in twenty minutes after the loss was reported.

The service costs the telephone company comparatively nothing and no charge for finding lost children would be made to parents or friends. In other places where it has been used it has made many friends for the telephone company.

A PRACTICAL ELECTRIC RAILWAY CONDUIT.

BY

Stephen D. Field

THE subject of conduits for electrical railroads has occupied considerable space in this journal of late, and is one which is seemingly beset with many difficulties, judging from the elaborate constructions described, and the poor success attending their installation. The various details of conduit construction have been thoroughly worked out by cable railway engineers, and it only remains for the electrical engineer to supply the necessary insulating conductors and contacts to secure a sure and lasting installation for electric traction. I have endeavored in the accompanying illustrations to point out one design which I think will answer the purpose.

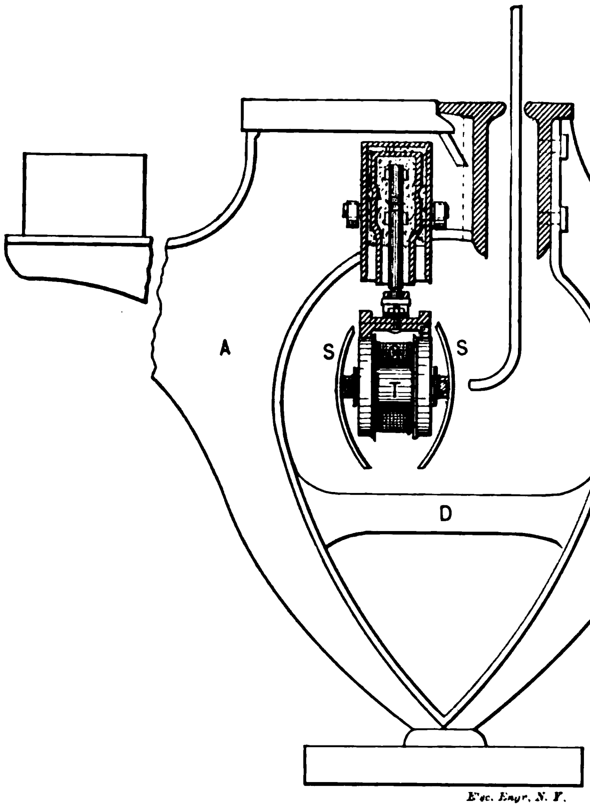


FIG. 1.—FIELD'S ELECTRIC RAILWAY CONDUIT.

The two factors most required in electrical conduits for railroads are perfect insulation and accessibility of parts. The conduit shown, has fittings so designed that all electrical attachments can be removed and renewed without disturbing the integrity of the conduit. The insulation may be so high that leakage will be inappreciable in any kind of weather.

The conduit frame, A, is made of cast-iron capped with steel at the slot. Insulation is provided by means of the well-known Brooks insulator, B, set at intervals of ten feet along the line of the conduit. The working conductor F is made in sections of twenty foot lengths arranged to "break joints."

Contact with the working conductor is obtained by what is termed a "magnetic trolley," T, which consists of two soft iron wheels fixed rigidly on a core which turns within a fixed coil, C; a current of 0.1 ampere passing through the coil causes the trolley wheels to adhere firmly to the iron working conductor. A spring is provided, just sufficient in strength to keep the trolley lightly against the conductor when no current is passing through the coil.

Immediately above each insulator a trap is provided through which the conduit may be cleaned and the insulators changed.

A brace, D, passes from side to side of the conduit at about one-third of its height; this secures rigidity of construction and allows of a lighter and less expensive yoke than is used in cable construction where no such device is permissible.

The switching is accomplished on the working conductor in precisely the same manner as on the surface track. The outer wall of the conduit may be used as one of the rails by allowing the flanges of the car wheels to run in the slot.

The lower portion of the conduit is so shaped as to provide adequate drainage, and it will be seen that water entering the slot falls clear of the working conductor and trolley. An insulating shield S encircles all the exposed metallic parts of the trolley, thus guarding against accidental contacts. Connection between the trolley and car is obtained by a hollow arm passing down through the slot, through which insulated conductors pass from the trolley to the car motor; the trolley is connected mechanically with the arm by a hollow wooden shaft hung in a gimbal.

The working conductor is of such a shape that it can be passed through the street slot and removed when necessary through the same opening. The joints in this conductor are bridged by strips or wires rivetted to their adjacent ends while current is supplied from an insulated trunk line laid parallel to the conduit, the working conductors being laid down in sections of five hundred feet and attached to the trunk line by branches containing cut-outs. As the trolley runs on the under side of the working conductor it is obvious that it always finds a clean surface to travel on; no dirt from the street can find lodgment there, magnetic adhesion provides an intimate contact with scarcely any weight and little resistance to progressive rotation.

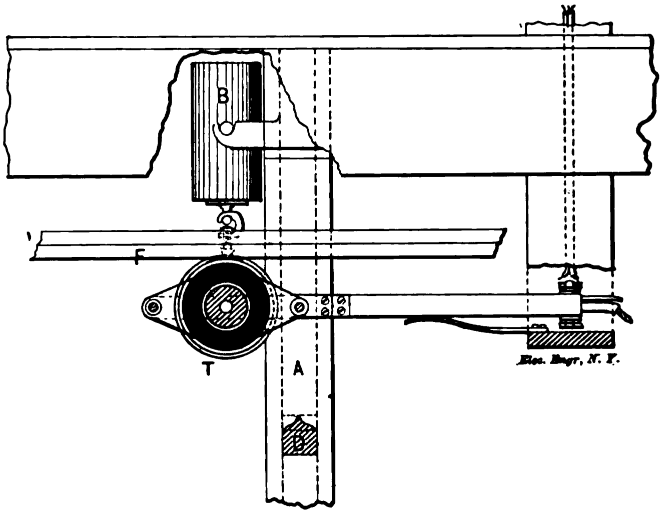


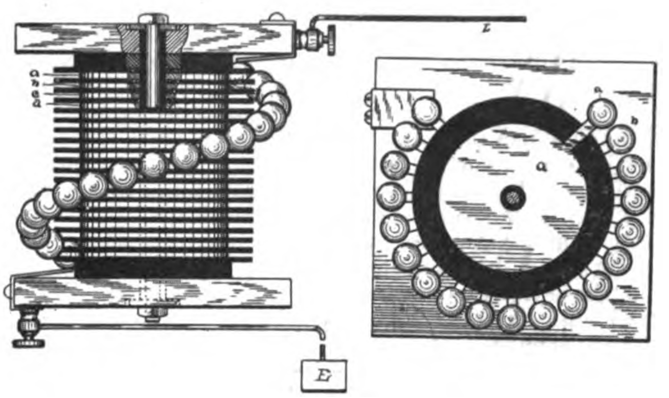
FIG. 2.—FIELD'S ELECTRIC RAILWAY CONDUIT.

In any cold climate the conduit may be kept open by means of a pipe laid on either side of the slot through which hot brine can be pumped from the engine house. A very few degrees of artificial heat communicated from the pipe to the conduit is required to effect this result, while the efficiency of this device may be greatly extended by having relays of heating stations at proper intervals along the track. As this heating system is only in operation during the prevalence of extremely cold weather, it is probable that a few days per year will cover its total time of operation, and it would seem that the expense attendant upon its operation is too trivial for consideration.

I am of the opinion that a road equipped as indicated will be found to be far more reliable in operation and unobstructive in installation than is the case where the working conductors are carried in the air. This system can be introduced for less than the cable system, and worked with greater speed, freedom from interruption and at a less cost of operation.

THOMSON'S MULTIPLE BREAK LIGHTNING ARRESTER.

The permanent connection of lightning arresters to earth makes it necessary to provide means for preventing the continuance of the arc started by a static discharge. Numerous devices have been designed for this purpose, and among the more recent our readers will recall that of Mr. Charles Wirt,[1] in which the discharge was made to pass over a series of short insulated breaks to ground. In a patent just issued to Professor Elihu Thomson, a somewhat analogous arrester is described depending upon the principle that where a number of breaks are made in an electric circuit, or where a number of discharge-spaces are successively placed to be traversed by a discharge, the total distance traversed by the discharge as given by the sum of the spaces or breaks may be made much greater than the striking distance of a discharge between only two plates where a single break exists only in circuit; or, in other words, that an induced discharge of lightning or a sudden high-potential impulsive discharge will leap a number of striking-spaces in succession, and such a number of them as would be several times the length of a single space which would be leaped by the same discharge.



Thomson's Multiple Break Lightning Arrester.

Prof. Thomson has found, on the other hand, that when such discharge has taken place and the potential of the line is such as would tend to maintain an arc at the breaks or striking-spaces, such potential can readily be made insufficient to do so by multiplying the number of striking-spaces, and that an arc is much more readily maintained between two plates with a single wide space than between a succession of discharge points or over a succession of spaces placed in series and which the arcing tendency has to bridge, particularly if the discharging surfaces or metallic parts are of good conductibility for heat, the difference being the formation of a number of arcs between cold metal in succession as compared with the formation of a single longer arc over two metallic points.

Experiments have also shown that the metal pieces interposed between each successive break should have some capacity for static charge, as this facilitates the successive breaking down of the disruptive spaces by a lightning discharge or sudden static effect.

The manner in which these principles have been carried out in practice will be seen in the accompanying engravings, Figs. 1 and 2, which show respectively an elevation and a plan of the lower part of the arrester. As will be seen, it consists of a series of metallic plates, *a b c d*, etc., separated by insulating-washers, such as hard rubber, each washer projecting a little distance outside of the metallic plates. Each plate, as *a*, Fig. 2, is provided with a lateral projection and carries a discharge-terminal, such as a ball, which lies within a small space of the succeeding terminal plate, as *b*, of the series. At one end of the series is a connection to the line L, and at the other end is a connection to earth E.

The effect of arranging the plates, as shown, is to give each one a certain static capacity, while the discharge-points or balls can be adjusted as to distance apart by simply swinging the plates around circularly, so as to arrange the balls or discharging-points in a spiral fashion or a zigzag fashion around the column of plates. At the same time additional plates might easily be built up on top of the column by unbolting the centre bolt and stringing new plates and insulating-washers thereon, so as to increase the number of discharge-points and adapt the apparatus to working with higher potentials on the line.

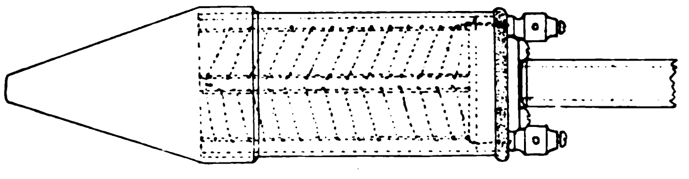
THE MINER ELECTRIC SOLDERING IRON.

The application of the electric current for heating purposes has already been introduced for a variety of purposes and the most recent of these is to the heating of soldering irons. Heretofore the irons employed for that purpose have been heated in open fires and the difficulty has always existed that the iron when taken out of the fire is usually too hot and then rapidly cools, so that its reheating is necessary.

With the electric current as the source of heat it is evident that a uniform temperature can be continuously maintained, and hence considerable time saved and greater convenience in working obtained. In order to adapt the current for this purpose Mr. Willard M. Miner, of Plainfield, N. J., has recently designed the soldering iron illustrated in the accompanying engraving.

This will be seen to consist of the usual soldering head having a cylinderical extension which contains two copper heating cores mounted upon a slate base. These cores are wound with No. 24 German silver wire, which is heated from the current led to the terminals.

An iron of this type is now undergoing trial at the works of the Tide Water Oil Company, at Bayonne, N. J., and during a recent visit we had occasion to observe the great convenience which the tool affords. In this establishment 36,000 cans are soldered each day and it is needless to say that every second of time saved is a material gain. The current is furnished by a dynamo and it is estimated that from four to six soldering irons of this type can be operated at an expenditure of one electrical horse power.



Miner's Electric Soldering Iron.

Having in mind the deterioration of the German silver wire with the continuous heating by the current, Mr. Miner is now experimenting with graphite as the conductor to be heated, by which he hopes to overcome the difficulty just mentioned. This material will allow of a much higher temperature being attained in a smaller space and will hence also be more economical of current.

Port Arthur, Man.—A by-law providing $75,000 for an electric road between Port Arthur and Fort William has been passed by a vote of over 10 to 1.

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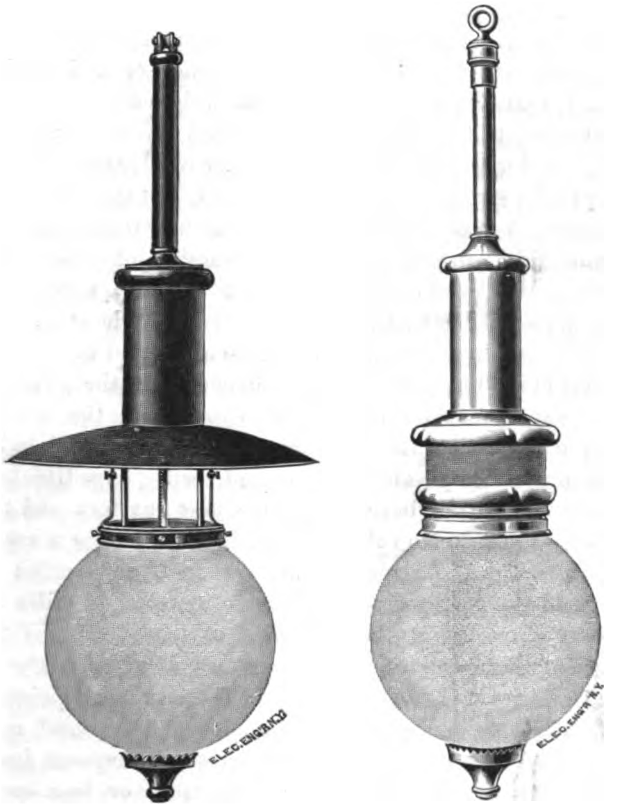
[1] The Electrical Engineer, May 7, 1890.

NEW SCHEFBAUER ARC LAMP.

The accompanying illustrations represent the new lamps now being brought out by Mr. R. Schefbauer, of this city, Fig. 1 showing the outdoor lamp in operation, and Fig. 2 with the globe lowered for trimming. The lamp employed by Mr. Schefbauer for incandescent circuits is of the differential type and entirely without springs. For incandescent circuits of 110 volts, two of these are run in series with a small resistance, and for 220 volt circuits five can be run in series without resistance. The five ampere lamp gives 500 c.p., while taking the energy required by only five 16 c. p. incandescent lamps. The 1,200 c. p. lamp takes 7 amperes. For street illumination a 10 ampere lamp is employed having 2,000 c. p. This lamp can be inserted equally well in series circuits. It is provided with an automatic switch block, so that when the carbons are burned out, a resistance is inserted equal to that of the arc. The lamp is also adapted for use on alternating circuits. Fig. 3 shows the ornamental type adopted for interior.



Figs. 1 and 3.—Schefbauer's New Constant Potential Arc Lamp.

THE INFLUENCE OF THE ELECTRIC SPARK AND OF THE SURROUNDING GAS ON THE RATE OF THE ELECTRIC DISCHARGE.

In a recent number of the *Journal of the Physico-Chemical Society of Russia*, M. P. Bakhmetieff states that he has repeated the experiments of M. Naccari on the loss of charge undergone by an electrified body when close to an electric spark, placing the whole arrangement under a bell-glass and filling it with different gases. Generally speaking, the electric spark accelerated the discharge, but charges of positive sign were the more rapidly dissipated in carbonic acid, and in coal gas, while negative electrification disappeared the more rapidly in air, hydrogen, and oxygen. M. Bakhmetieff attributes these results to an unstable molecular allotropic modification of the gases by the electric spark which renders them conducting, but only to electricity of one particular sign. M. A. Nacarri, in the *Atti della R. Accademia delle Scienze di Torino*, Vol. XXV., states, with reference to some further experiments of his, that the influence of the electric spark on the rate of discharge of an electrified body is much diminished by the presence of vapor of water, alcohol, essence of turpentine, ether, and petroleum. He further calls attention to the fact that the presence of a piece of phosphorus near an electrified metal ball causes it to rapidly discharge. This phenomenon is, he says, apparently closely connected with phosphorescence, since it only takes place if the phosphorus emits a glow reaching to the electrified body. The phenomenon ceases in the presence of bodies, like essence of turpentine, which cause phosphoresence to disappear.

THE CONDUCTIVITY OF DISTILLED WATER.

Although the electrical conductivity of distilled water is extremely small, it was not found too small to be computed by Kohlrausch, who placed the value approximately at

0.000,000,000,025,

the conductivity of mercury being taken as unity.

W. Ostwåld has recently been contending in Gilbert's *Annalen der Physik und Chem.* (series [2], vol. xl., p. 735), that the electrical conductivity of distilled water is, in a great measure, due to the presence of carbonic acid gas held in solution. This gas is a well-known impurity in distilled water, sometimes causing it to give an acid reaction with delicate indicators. It can be removed by distillation over a considerable quantity of some base, as, for instance, pure lime.

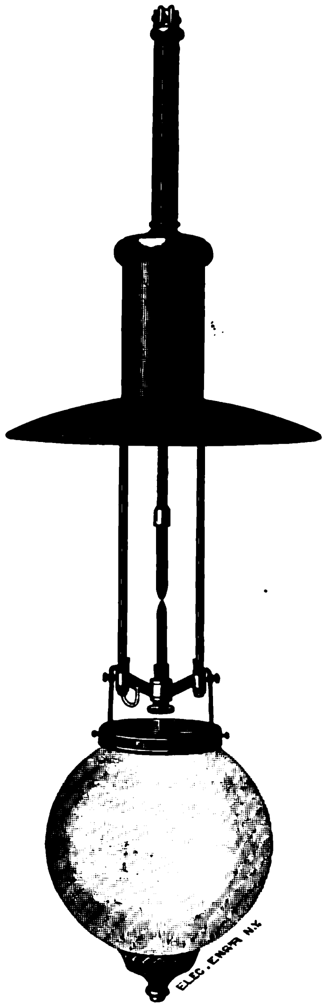


Fig. 2.—Schefbauer's New Constant Potential Arc Lamp.

Ostwald's paper is written to disprove the theories of Pfeiffer concerning the cause of the electrical conductivity of distilled water.

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VOL. XI. NEW YORK, JANUARY 21, 1891. No. 142

> *"The man of true genius never lives before his time. Though he may catch a glimpse of the coming light as it gilds the mountain-top, long before it has reached the eyes of his contemporaries, and though he may hazard a prediction as to the future, he acts with the present."—Joseph Henry.*

UNDERGROUND ELECTRIC ROADS FOR NEW YORK.

THE rapid transit agitation in this city has now assumed formidable proportions, and it is safe to predict that 1891 will see steps taken to satisfy the necessities of the community. The Rapid Transit Commissioners have begun their work with every evidence of sustained zeal and good intent, and the press of the city is most outspoken in its advocacy of the popular needs. Particularly and specially must we commend the attitude of the perennially vigorous *Commercial Advertiser*, which, with an instinct, the keener, perhaps, for its long years of public service, has sprung to the front of the movement and has made "Rapid Transit!" its rallying cry for every New Yorker in whose breast is harbored any feeling of hope and pride and anxiety for the future of this great and imperial city.

In its issue of Friday, January 16, the *Commercial Advertiser* devotes a whole page to the discussion of rapid transit, accompanied by an editorial in review of the subject. Then for the first time, probably, in the pages of a New York daily were summed up the marvelous results attained by electricity during the past five years in America, as a motive power for street railway purposes. Such results we may briefly recapitulate for ourselves in the totals of nearly 300 electric roads, nearly 4,000 motor cars, over $50,000,000 of investment, and about 700,000,000 passengers transported safely per annum. The *Commercial*, however, does not commit itself to any advocacy, but, pointing to these figures, and to the recent successful underground electric railway work in London, suggests the inevitable inference that New York can meet its necessities by also putting in an underground electric road. In support of such an inference, it has also begun to collect the views of a number of leading electrical inventors and electrical engineers in this part of the country.

The arguments in favor of an underground road, and of its operation by electricity are so numerous and so important, that when duly counted and weighed they will be found irresistible. Our elevated system has been a great boon, but for the last five years has proved utterly inadequate to the strain of the crowded hours. At the same time no more such roads are wanted, for even now it is impossible in New York city to live beyond earshot of those that exist; so that even on the sole ground of the noise they make, no addition to the nuisance can be tolerated. To operate them by electricity would be a decided mitigation of their evils, but even then the capacity of the existing structures cannot be greatly increased. In the second place, no addition to the surface facilities, whether by cable or by any electric method, will expedite and shorten the journey between the business quarters and the uptown suburbs. No cable or electric road will be allowed to run through the streets at more than 6 or 8 miles an hour, and the elevated roads make from 10 to 12 miles an hour now, except at the extremes of load. Hence the choice of measures of relief narrows down quickly to some underground method, and as soon as that point is reached it is seen at once that a wholly underground road will be infinitely cheaper than one that half exposes itself and inflicts upon abutting property more or less costly burdens as evidence of its propinquity. The steam underground roads of London keep as near as they do to the surface because they must rise occasionally to breathe, and as State Engineer Bogart pointed out some time ago, ventilation in such underground steam roads, as in all long tunnels, is to-day the only big problem. But the underground electric road in London, while accentuating all the merits of the old steam underground roads, adds several new merits of its own, and one of the chief is the fact that with electric locomotives the ventilation difficulties are at once almost wholly removed.

Moreover, an underground electric road can easily do its own lighting and heating, the same small steel or copper bars that deliver current to the motors delivering it also to lamps and heating coils, while, if necessary, separate circuits can run through the tunnels, rendering the stationary lights there quite independent of the lights in or upon the trains. The passengers can also be transferred to and from the surface by electric elevators, of exactly the same nature as the hundreds already in use. In fact, in not one single detail does the proposed work involve difficulties that the electrical engineer has not now encountered and most successfully disposed of. It is simply a question of confidence on the part of the authorities, with sufficient concessions to encourage capital in carrying out the enterprise. None of us who travel daily up and down New York and see the vast masses of humanity in transit can have any doubt as to the financial success of a road honestly built and embodying the best engineering and electrical practice of the times.

ELECTRIC RAILWAY CONDUIT DETAILS.

Many of our readers will no doubt recall the rush of inventions that followed the first practical demonstration in electric lighting, and were brought forth mainly by the difficulties and necessities involved in the service. We can distinctly trace a similar tendency at the present time, in which inventors are putting forth their best energies to the solution of problems in electric railroading. Among these problems, the methods of operating the conductors below the surface of the earth are receiving not a small share of the attention, and to the many arrangements which we have already described we add this week another due to Mr. Stephen D. Field, who has long made this subject a special study. Mr. Field rightly assumes that a serviceable underground electric railway system must be strong enough to withstand all the adverse influences that are brought to bear upon it, and naturally turns towards the construction adopted for cable railways, as well as to that which experience has shown to be the best adapted for the purpose to carry out a thorough insulation of the conductors. Mr. Field employs a well-known and a long-tried type of insulator, so that in two important elements he is guided by the successful practice of the past. The method of making contact with the conductor employed by Mr. Field will also attract attention as being a neat method of securing intimate contact and of maintaining the conductor clean with the least wear upon it.

While thus the underground problems are not being neglected, the overhead ones still occupy the attention of not a few and, indeed, may well claim the attention of inventors. The overhead trolley wheel employed for taking a current from the conductor, simple as it is, embodies an enormous amount of thought, and is the result of many trials and failures. Even as it stands, it labors under difficulties which are inherent in any device of this kind made of a material having an unyielding nature. The smallness of the contact evidently introduces a point of resistance which results in the heating of the wheel with attending difficulties, and it was therefore highly desirable to increase the contacts and to reduce the shocks which a solid wheel encounters in its course. The device due to Mr. Charles A. Lieb, which we illustrate in another column, seems well calculated to avoid these difficulties and marks another advance in the working details of electric railroading.

HENRY'S ELECTRIC CAR GEAR.

The benefits to be derived from operating the motors on electric cars continuously, whether the car be at rest or in motion, though but recently called into prominence, is by no means a new departure in electric railroading. Among those who have devoted their attention to this branch, Mr. John C. Henry was probably the first to suggest this mode of operation and indeed to put it into practice more than five years ago. At that time, however, the opportunities which have since developed for the application of new ideas to electric railway practice were but limited. Now, however, the obvious advantages of electricity being recognized, the field presented for the application of meritorious devices is practically unlimited. An analysis of Mr. Henry's gear, which we illustrated in our pages last week shows it to consist of mechanism which permits of the car axle being directly connected to the armature shaft, at the same time permitting it to be disconnected without stopping the armature. At full speed, therefore, practically no loss in transmission is sustained through intermediate gearing, which with Mr. Henry's device acts as a solid connecting link. The practical tests of the motor we understand have been so successful that little doubt is entertained of its commercial adoption in the future. In addition to what has been stated in the descriptive article, it may be added that after the speed is got up, the armature shaft having been clutched directly to the internal gear, the rate of travel on a favorable track will easily compete with that of the fastest locomotive.

THE EDISON GENERAL'S ANNUAL REPORT.

Despite the fact that the annual meeting of the Edison General Electric Co. was held this week after our usual hour of press, we have succeeded in presenting a very full review in this issue of the remarkable statistics contained in the annual report. Such a document, at such a season, is a magnificent reply to those who, applying a pessimistic interpretation to disaster here and there, have doubted the stability of the electric light and power industry as a whole and have insisted that there was no health in Israel. We commend the report to our readers for careful perusal, so that if passing clouds have perturbed them they may breathe freely and take courage again. Summed up briefly, the report shows a growing business of $10,000,000 per annum, orders on hand for six months for a working force of 6,000 employees, net earnings for the year of 8 per cent. on the total stock, and gross profits, allowing depreciation, &c., of $1,896,177. It is noteworthy that the Edison Electric Light Co.'s net and undistributed receipts for the year were just over $1,000,000, and as the General Co. is understood to own over 99 per cent. of the Electric Light Co.'s stock, that sum might in reality, it would seem, be added on to the gross profits in computing the actual yield of the industry. The apparatus sold from Schenectady shows an increase of 117 per cent. over the preceding year, and the product of the East Newark lamp works has increased 64 per cent., while the capacity has just been raised from 11,000 to 25,000 lamps per day.

Storage Battery Improvements.

To obtain lightness and solidity of form with long life of the plates has been the constant dream and aim of the storage battery maker, and the variety of forms designed with this object in view afford a valuable example of the evolution of an idea in seeking to accomplish a given result. Among the methods tried has been one in which the lead grid has been entirely avoided. In such plates as made heretofore the mass of material was uniform in texture throughout the plate, but we illustrate in this issue a departure in this direction due to Mr. S. C. C. Currie. This inventor has sought to secure lightness with strength by producing a plate entirely of active material in which the supporting frame consists of a compressed active material, while the additional working part itself forms a body with the other and is in direct contact with it.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—X.

(*Copyright. The Electrical Engineer.*)

BY

Herbert Laws Webb

To return to our specific example of the test for insulation resistance. The behavior of the spot should be carefully watched, and at the end of one minute from the time of turning on the current the exact deflection should be noted. This deflection serves for working out the insulation resistance by comparison with the galvanometer constant; the figures for insulation resistance are generally stated to be "after one minute's electrification."

We will assume that the cable being tested is 2,640 feet long and that the deflection after one minute is 60 divisions on the scale. The constant of the galvanometer being 30,000, the absolute insulation resistance of the cable is $\frac{30000}{60} = 500$ megohms. As cables vary in length it is obviously useless, for purposes of comparison, to know the insulation resistance of a cable without also knowing its length, and even so it is not convenient to have to refer to two separate quantities; therefore it is usual to speak of the resistance per unit of length, and the insulation resistance per mile is the figure by which we can best judge of the actual condition of a cable.

In the present case the absolute insulation being 500 megohms and the length 2,640 feet, or .5 of a mile, the insulation resistance per mile will be 500 × .5 = 250 megohms. If the cable were 5 miles long and gave the same deflection the insulation per mile would be 2,500 megohms.

The insulation resistance per mile is always found by multiplying the absolute insulation, or the insulation for the whole piece, by the length; if the length is less than one mile the insulation per mile will be less than the absolute; if the length is greater than one mile the insulation per mile will be proportionately greater than the absolute. Thus if a piece of wire one-tenth of a mile long showed an insulation of 10,000 megohms, its insulation per mile would be 1,000 megohms. If a cable 10 miles long showed an absolute insulation of 100 megohms its insulation per mile would also be 1,000 megohms.

In testing long submarine cables it is usual to keep the current on for a number of minutes, sometimes for half an hour, noting the deflection at the end of each minute. The electrification and general behavior of the cable under test can then be observed with care. After the zinc current has been on for thirty minutes the cable is put to earth for five or ten minutes and the discharge or earth readings are noted; then the copper pole of the battery is applied and a set of readings taken, after which the cable is again put to earth and the discharge noted at intervals as before.

With short cables it is scarcely possible to make such long tests unless the battery power employed is very great or the galvanometer extremely sensitive, as the deflection obtained from a short cable of high insulation is so small, that, at the usual rate of electrification, there would be no deflection at all, or else a stationary one, long before the thirty minutes' readings had been taken. Nor is it necessary to make such elaborate tests on short cables, as if there is any defect present it will be revealed by a few readings or by taking reversals, as previously explained.

In testing cables or wires insulated with homogeneous compounds in a factory they should always be immersed in water kept at a definite temperature during the whole time, not less than two or three days, that the cable is submerged previous to the test. The usual standard temperature to which cables are subjected to in factory tests is 75 deg. Fahrenheit. This is a higher temperature than they are likely to be affected by when in use, the conditions being purposely made unfavorable to the cable in order that any possible defects of manufacture, which might not show up at once under ordinary conditions, may be revealed before the cable is accepted and put into use.

In testing telephone cables containing 50 or 100 conductors it is necessary to test each wire separately for insulation and a certain number for capacity and resistance. As a general rule, one minute's reading is considered sufficient for each conductor, as a cable which practically depends upon the soundness of the lead sheath for its insulation will show very quickly whether the condition of the cable is good or bad. Another reason which renders readings with different poles of the battery a poor guide to the condition of an underground cable, insulated with fibrous material, saturated with paraffin or insulating compound, is that the insulation is affected by heat to a very considerable extent, and it is also very quickly lowered by the presence of the smallest amount of moisture in the cable. But by whichever cause the insulation is lowered, the readings with opposite poles of the battery will be different, and therefore no clue is really afforded to the actual cause of an unsatisfactory test on a cable of this class; it may be either heat or moisture, unless, of course, there exists an absolute certainty that the cable is nowhere subjected to undue heat. If, however, moisture once gains an ingress into a cable insulated with fibrous material, the insulation will fall very quickly and the entire cable will soon be practically dead grounded, owing to the rapid absorption of moisture characteristic of such substances.

The insulation of a telephone cable should be fairly regular throughout, each conductor giving about the same insulation, but this is rarely the case, even when the average insulation is very high. For this reason the average of all the conductors is always taken as a guide to the general condition of the cable. A certain limit should be set, below which no conductor is to fall, as the average insulation may be up to the mark owing to high results from a number of the conductors, while others may test so low as to indicate the existence of a fault. As a general rule, if the insulation of a telephone cable is reasonably high and fairly uniform throughout, the condition of the cable is good. With a very high insulation there may be apparently great irregularity between the different conductors, owing to the difficulty of reading very small deflections under the ordinary conditions of testing; if, for instance, the insulation varies from 5,000 to 10,000 megohms per mile it may safely be assumed that there is nothing wrong; If, however, the majority of the conductors show an insulation of 500 to 700 megohms per mile, and about eight or ten conductors show a much lower insulation, ranging say from 30 to 100, while the average of the whole cable would be but slightly lowered by these few weak conductors, still they would indicate the existence of an incipient fault, which might in a short time develop sufficiently to seriously affect the condition of the whole cable. The uniformity of the test is therefore the best indication of the soundness of a cable of the description we are discussing.

In testing telephone cables for insulation all the conductors, except the one being tested, must be grounded; otherwise some of the conductors, those toward the centre of the cable, will have the benefit of a greater thickness of insulation than others. This is usually done by lacing a fine bare wire among the binding posts on the terminal head and connecting it to the iron box or to the lead pipe, sufficient slack being left in the wire for it to be pulled clear of each binding post in succession as the lead is connected.

One minute's reading with the zinc current is taken on each conductor and the insulation is worked out by the deflection obtained at the end of the minute, according to the method previously described. In calculating the average insulation of the cable, the deflections must not be added up and averaged, and the average insulation worked out by the average deflection; the fairest method is to take the average of the insulation resistance of all the conductors.

To instance the different results given by the two methods if the deflections are at all irregular, let us assume that we are testing a cable 2,640 feet long. The constant of the galuanometer is found to be 30,000 and the first five wires give deflections after one minute's electrification of 30, 50, 30, 10 and 30 respectively. The average deflection would be 30, which would give an insulation of 1,000 megohms absolute and 500 megohms per mile. Working out the deflections separately, however, we get a different result:

No.	Deflection.	Insulation Absolute.	Resistance Per Mile.
1	30	1,000	500
2	50	600	300
3	30	1,000	500
4	10	3,000	1,500
5	30	1,000	500
Average Insulation,		1,320	660

Thus it is obvious that unless the deflections are extremely regular throughout, the average insulation should not be determined by the average deflection, as would readily occur to most, but by summing the insulation resistances of all the conductors and averaging. This would be very laborious if every conductor gave a different deflection but it generally happens that the same deflection occurs frequently in a test on a hundred conductor cable, which considerably lessens the labor of working out the test and obtaining the average insulation.

In some cases it simplifies matters to work out results by logarithms. As an example, suppose the cable being tested is 3,475 feet long, and that we are working with a constant of 42,500. The first deflection after one minute's electrification is 37; to find the insulation absolute and per mile of this wire we proceed as follows:

Log. 42,500=4.62838
" 37 1.56820
3.06018 = 1,148 megohms absolute.

Turning 3,475 feet into decimal parts of a mile we get .658; the log. of this added to the log. of the absolute will give the insulation per mile, thus:

Log. 1,148=3.06018
" .658=$\bar{1}$.81822
2.87840 = 756 megohms per mile.

When dealing with large numbers it is no doubt more convenient to use logarithms, and, with one man to do the figuring and another to look up the logarithms and numbers, it is no doubt quicker than working out by division and multiplication. It must always be remembered that in multiplying by logarithms the logs. are added, and in dividing, subtracted.

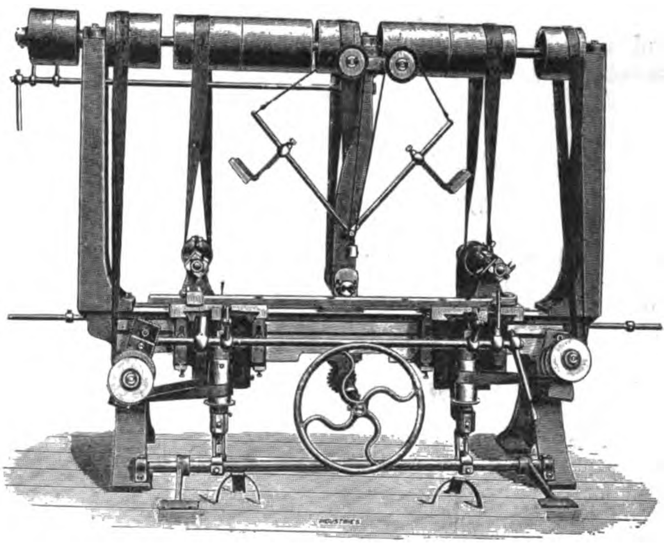
A BROKERS' TELEGRAPH SERVICE.

President Baker, in his address to the members of the Chicago Board of Trade, at their annual meeting, January 12, charged the Western Union Telegraph Company with fostering bucket shops, and said that he believed that the time is ripe for the members of the several exchanges whose relations are intimate and important to establish their own telegraph lines. A committee of five was appointed at the meeting to formulate such a plan as suggested by President Baker.

Second Lieut. **Frank Greene**, Signal Corps, now on duty at Santa Fé, New Mexico, has been ordered to proceed to the following points and make a thorough inspection of the Signal Service stations there: Forts Sill and Reno, Oklahoma Territory; Dodge City, Kan., and Pueblo, Col.

MACHINE FOR SHAPING AND BORING TELEGRAPH POST ARMS.[1]

The accompanying illustration represents an ingenious machine which has been lately made by Messrs. John Pickles & Son, Hebden Bridge *via* Manchester, for preparing telegraph post arms. These arms are usually made from the best selected English oak, and vary in length from 2ft. to 4ft. They are in the first case planed on the four sides by means of a special planing machine made by the above-named firm. They are then sawn to the exact length required by means of a double cross-cut sawing machine made specially for the purpose. The arms are then passed along to the machine we now illustrate. This machine is provided with a fence bar, in which the arms are held fast by a novel screw clamp. By means of the hand lever shown to the right the arm is carried, by the slides, between cutters revolving at a high speed. These cutters complete the end chamfering, and at the same time the central hole is bored by a revolving boring bit. After this the slide carrying the arm is moved up against an adjustable stop, and the operator turns the large hand wheel. This is connected by bevel and other gearing to the cutter headstocks, and causes the latter to move towards each other up to a given point in accordance with the length of chamfer required, which may be from 7in. to 17in. in length. The cutters revolving at a great speed take off the chamfer on both sides of the arm and also at both ends at the same time. The bars shown at the ends of machine have gauge stops fitted for giving the length of traverse required. The headstocks are after this rapidly wound back to their first position and are ready for the next operation. The operator then places his foot on the foot lever, which causes the two heads carrying revolving boring bits to rise and bore the holes at each end required for fixing the insulators. The pads connected with cords and levers on the central standard are intended to prevent the boring bits splintering the wood when coming through the top side.



Machine for Making Cross Arms.

It will be seen that the machine is quite self-contained, and has the driving shaft placed overhead and supported upon standards fixed to the main bed. The arrangements for dealing with the various lengths of arms have been carefully thought out. At the official test of the machine in the presence of the purchasers the wooden arms were finished at the rate of three per minute.

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[1] *Industries.*

ON THE ARRANGEMENT OF VATS IN ELECTRO-DEPOSITION.—II.

BY

Let us see now if it is possible to vary the consumption of energy while keeping the deposit constant. To keep the deposit constant it suffices to maintain the current unchanged. From (3) we see that with C constant the term $C\varepsilon$ cannot be changed but will also remain constant, the factor ε being practically a constant. We can, however, vary r or R, especially the latter. We may do this by varying either the conductivity of the solution itself, or the electrode surface (a), or the distance (l) between the electrodes, or all three quantities simultaneously.

Let us, for instance, double the surface ($=2a$) of the electrode, and place them only half as far apart($=\frac{l}{2}$), while we change the constituents of the electrolyte so as to reduce the specific resistance (s) one-half. We then have for the liquid resistance

$$\frac{l\,s}{2 \times 2 \times 2\,a} = \frac{l\,s}{8\,a} = \frac{R}{8},$$

and for the total resistance of the cell (neglecting the change in r);

$$(r + \frac{R}{8}).$$

The energy consumed will be

$$W' = C^2\,(r + \frac{R}{8}) + C\,\varepsilon \qquad (4)$$

which is less than before, since

$$W - W' = \left[\,C^2\,(r + R) + C\varepsilon\right] - \left[C^2\,(r + \frac{R}{8}) + C\varepsilon\right]$$
$$= \tfrac{7}{8}\,C^2\,R, \qquad (5)$$

this value (5) representing the saving effected by the change.

We will now assume eight of these low resistance cells to be placed *in series*. The resistance of the connections is supposed to be negligible.

The energy required will be

$$W'' = 8\ W' = 8\ \left[C^2\,(r + \frac{R}{8}) + C\,\varepsilon\right]$$
$$= 8\,C^2\,r + C^2\,R + 8\,C\,\varepsilon \qquad (6)$$

As the same current passes through all eight cells, the total deposit will be eight times what it was with the small cell. The energy consumed has, nevertheless, not increased to eight times its original value. Comparing (3) and (6) we find the difference to be only

$$W'' - W = (8\,C^2 r + C^2\,R + 8\,C\varepsilon) - (C^2\,r + C^2\,R + C\varepsilon) = 7\,(C^2 r + 7\,C\varepsilon) \qquad (7)$$

In practice the distance between the anodes and cathodes is generally fixed and the most convenient way to reduce the resistance is by increasing the surfaces; which can be done by connecting more pairs of plates in parallel, or, what is equivalent thereto, by connecting several cells or "vats" in parallel.

Let us therefore connect in parallel circuit n cells or vats, each having the same values of r, R, and ε as the first one considered. The joint resistance of the group will be $\frac{1}{n}$ of each vat taken alone. Hence we can add n such groups in series and the total resistance of the whole will still be only equal to one vat. As we desire to maintain the current (C) constant it will be divided equally between the n groups or series of vats, each of which will receive $\frac{1}{n}$ of the total current, and its depositing rate will be only $\frac{1}{n}$ of what it was in the case of a single vat. But, as there are n^2 vats in all, the total rate of deposition will be $n^2 \times \frac{1}{n} = n$ times greater than before, or in direct proportion with the number of vats *in series*.

Let us now see how much power is consumed. The current through each vat being only $\frac{C}{n}$, the energy consumed in each vat is

$$\frac{C^2}{n^2}\,(r + R) + \frac{C}{n}\,\varepsilon; \qquad (7a)$$

and the total power required for the n^2 vats is,

$$W''' = \frac{n^2\ C^2}{n^2}(r + R) + n^2\,\frac{C\varepsilon}{n}$$
$$= C^2\,(r + R) + n\ C\ ; \qquad (8)$$

which differs from the power required for one single cell (3) by only

$$W''' - W = [\,C^2\,(r + R) + n\ C\varepsilon] - [\,C^2\,(r + R) + C\varepsilon]$$
$$= (n - 1)\ C\varepsilon \qquad (9)$$

The rate of deposition is, therefore, increased n times, while the power is increased as many times as (8) contains (3), that is,

$$\frac{C^2\,(r + R) + n\ C\varepsilon}{C^2\,(r + R) + C\varepsilon} = 1 + \frac{(n - 1)\ C\varepsilon}{C^2\,(r + R) + C\varepsilon} \qquad (10)$$
$$= \frac{W''' - W}{W} + 1. \qquad (11)$$

These equations are general and apply to all cases of electro-deposition. To obtain the net value of the ratio (10) in the case of copper deposition, we must now return to the factor ε, and consider it more closely. When the anode is of copper, and worked with the usual acidulated sulphate solution the polarization is all but inappreciable. Under normal conditions, for each atom of copper deposited on the cathode from the solution there is a corresponding atom dissolved from the anode, and added to the solution. According to thermo-chemical theory, therefore, the two actions should compensate each other perfectly and there ought to be no polarization whatever. In practice it is a very small factor. J. T. Sprague places its value at .02 volt. In his paper on electrotyping before the (then) Society of Telegraph Engineers and Electricians in April, 1885, Capt. H. R. Sankey, R. E., states that the value of the counter E. M. F. (ε) varies from .005 to .016 volt. Mr. A. F. Delafield[1] gives a still lower value (.002 volt). The writer has found that in electrotyping, with proper care, the polarization can be kept below .01 volt. In some cases it may rise to a value several times higher. This is apt to occur when the solution becomes altered in character or when the anode and cathode surface vary in relative areas. If the plates are of unequal surface, or, what amounts to the same thing, if the circulation of the electrolyte is unequal, there will be a tendency either to evolve oxygen at the anode, or hydrogen at the cathode. If the current density be excessive, both actions may occur simultaneously. If the former occurs alone the solution becomes impoverished, if the latter, it becomes enriched. In either case the resulting polarization adds to the loss of potential by increasing the factor ε.

The polarization is also influenced by the kind and amount of impurities found in the copper of the anode plates. For each case there is a maximum current density above which the polarization increases rapidly. When the solution is warm and diffusion is further aided by agitation the polarization does not increase so early or so rapidly, as the current density is raised.

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[1] THE ELECTRICIAN & ELECTRICAL ENGINEER, August, 1886.

By connecting more vats in parallel to increase the surface, the current density is reduced, and the conditions are more favorable to low polarization.

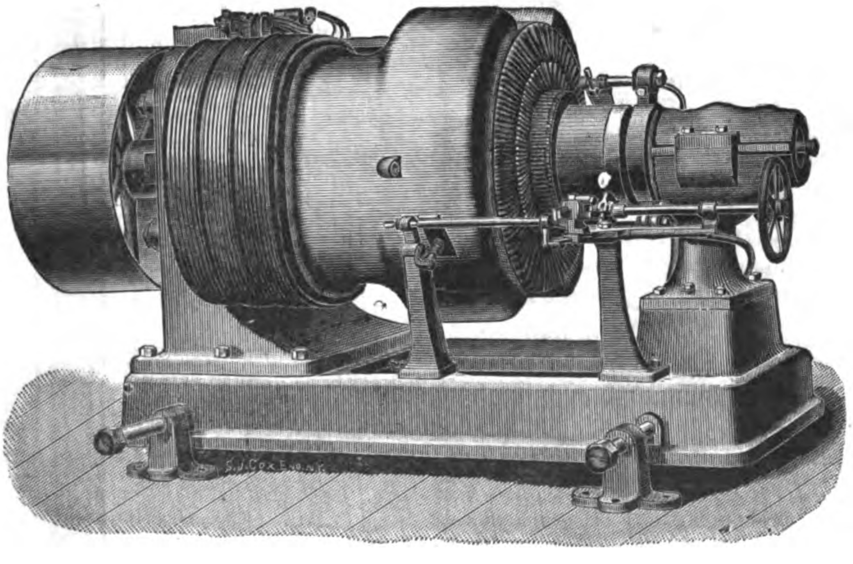
The value of ε, for the case of copper, is in any event so small that the fraction in (10) will always be small. The value of $\frac{W''' - W}{W}$ will, it is evident, increase with the number of vats; the rate is, however, very slow. When n is taken $= 100$, which means 1,000 vats, this fraction, using actual data, will usually reduce to 6 or less, making the total $(1 + 6) = 7$. With impure anodes, and varied conditions of working, the total (11) may rise to as much as 10. In other words the deposit would be increased 100 times and the power 10 times, as compared with a single vat. As a rough approximation the power would be $\sqrt{n}$ times that of one vat and the ratio of deposit to power would be as

$$n \text{ to } \sqrt{n} = \frac{n}{\sqrt{n}} = \sqrt{n}.$$

The power consumption, therefore, does not quite remain constant, as implied in the statement of M. Fontaine quoted at the beginning. Yet it increases so slowly with respect to the rate of deposition that the theory then advanced is certainly much nearer the truth than is the view of those who maintain that the power expenditure is the same under any and all circumstances.

THE NEW EDISON ARC LIGHT MACHINE.

As is well known, Mr. Edison has always advocated the use of the incandescent lamp for all kinds of illumination, including both interior and street lighting, and it was with the object of accomplishing the latter purpose that the well-known Edison "municipal system" was devised. In response, however, to the many demands made upon it for arc plants, the Edison General Electric Co. has now brought out a complete system of this kind, which enables it to furnish every desired kind of electric lighting and power apparatus of the nature named.



New Edison Arc Light Dynamo.

The new dynamo designed for the purpose, known as the Edison two core arc machine, is illustrated in the accompanying engraving, and derives its name from the design of the field magnets. Only two magnets are used, set at a slight angle, separating at the pole pieces to admit the armature, and approaching each other where they join the yoke. This construction is electrically the most efficient possible, for the large amount of iron in the field magnets and the short length of wire in the coils, together with the compact form of the whole machine keep the internal losses small.

The field coils are wound in sections, and slipped on over the cores; the terminals are then brought to binding posts on a connecting board above each magnet core. All the connections are thus easily accessible, and in case of injury to the winding the fault can be immediately localized and the injured section replaced in a few minutes.

A Gramme ring armature is used, with the core built up of alternate rings of soft iron and paper and held to the shaft by gun metal spiders. The armature winding forms a continuous coil of many turns around the core, and is connected to the commutator by copper strips soldered to loops left at equal distances around the circumference of the ring for this purpose. The strip connectors play an important part in the ventilation of the armature, acting as an exhaust fan, and keeping a current of air constantly circulating through the interior of the machine.

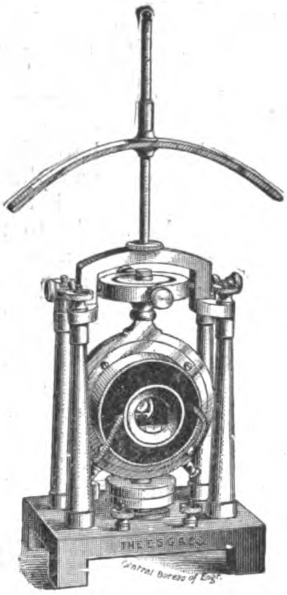
The commutator is built of hard drawn copper bars, insulated throughout with mica, and the insulation of all parts of the dynamo has received thorough attention. The regulator is attached directly to the dynamo base frame, where it is out of the way, and consists essentially of a small flat armature, pivoted near one pole piece, and a rack and pawl mechanism driven by a short belt from the dynamo shaft arranged to shift the brushes around the commutator in one direction or the other, as the governing armature is attracted more or less powerfully by the pole pieces. The field magnet thus is the controlling magnet of the regulator, so dispensing with all external regulating mechanism. Thorough lubrication of the machine has been provided for in the employment of the Edison self-oiling bearings. In these the oil is steadily fed to the bearings while running, they cannot clog nor run dry, they are dirt proof, and great savers of oil; while they require attention only at intervals of ten days to a month.

Two styles of lamps of improved design are employed in connection with the arc machine, the single lamp and the "triple" carbon. The latter takes the place of the ordinary double carbon lamp and maintains the lengthened period of burning by the employment of two upper positive carbons and a single flat negative carbon. The mechanism does not differ essentially from that of the single lamp.

All the other details which go to make up a complete arc lighting system have also been completely worked out, including switchboard, ammeter, lightning arrester, and other accessories.

THE FREY PORTABLE REFLECTING GALVANOMETER.

This instrument, the invention of Mr. Charles P. Frey, chief electrician of The E. S. Greeley & Company electrical laboratory, embodies the essential features of Thomson's reflecting galvanometer, and is extremely sensitive. Its principal feature is that it can be instantly prepared for use by releasing the coils, which are suspended by means of a universal joint, and thus require no leveling. When not in use the fibre suspended magnet and mirror, as well as the pendant coils, are securely locked by means of a compound bolt operated by one turn of an independent key, doing away with the danger of breaking the fibre, a danger to which the ordinary type of fibre suspension is extremely liable when at all roughly handled, and one which may be a serious annoyance.



Frey Portable Reflecting Galvanometer.

This galvanometer is especially adapted for rapid subway testing, since it may be rendered direct reading by attaching a pointer. For more delicate tests, by using a lamp, stand and scale, a high figure of merit may be obtained.

A STRIKE OF RAILROAD TELEGRAPHERS.

As a result of the refusal of the Chicago, Milwaukee and St. Paul Company to accede to the demand of the station agents and railway telegraph operators on the lines of that system, a strike was determined upon to begin Friday, Jan. 16. Grand Chief Thurston, of the International Order of Railway Telegraphers, sent out an order to every agent and operator in the employ of the road to send in his resignation, to take effect Friday, January 16, at 9 A. M. This course was taken by the men in order to protect their men, who would be liable for resulting damages had there been a strike without previous notice being given. There are about 450 who will go out. Chief Thurston says: "We are in splendid condition, and if necessary, can support these men for a year. Station agents and operators all over the country are rallying to the support of the movement, and we shall have ample funds to carry on the fight to a successful termination. I do not suppose our men quitting will interfere with the running of trains, but the trains will have nothing to carry. Nearly all the operators at way stations are agents. Now, when they quit, who will receive freight or sell tickets? The company cannot let incompetent men do that work."

Chester, Pa.—The stockholders of the Chester Electric Light and Power Co. met Jan. 12, in the office of the company on Third street and elected a president and board of directors, as follows: President, G. P. Dennis; directors, C. W. Perkins, F. G. Sweeney, Joseph Deering, D. P. Paiste, Joseph Messick, John McGolrick, William Burnley, H. B. Black, Hubert J. Riley, F. S. Hastings.

THE STEWART-HALL TRAIN ORDER SIGNAL.

There has for a long time existed in the minds of railroad men the conviction that railroading needed a simple, and at the same time effectual, train order signal. To meet this demand, Mr. Robert Stewart, Supt. of Telegraph of the Central Railroad of New Jersey, and Mr. W. P. Hall, the well-known inventor of the admirable system of the Hall Signal Co., have perfected the apparatus illustrated in the accompanying cuts. Their very ingenious signal was exhibited in operation to a number of prominent railroad men at Somerville, N. J., on January 15th.

The device consists of a semaphore, Fig. 1, or disc, placed alongside the track, a switch, Fig. 2, placed on the operator's desk, beside his telegraph instruments, and an indicator box on the opposite wall of the office, Fig. 3, a closed circuit battery being used. The semaphore is attached to a rotating armature which is held at safety when the circuit is closed, as shown at s, Fig. 4. It is also counter-weighted so that when no current is flowing through the magnets, the semaphore is brought to the position shown in Fig. 1. The details of the indicator are shown in Fig. 5 and at D, Fig. 4.

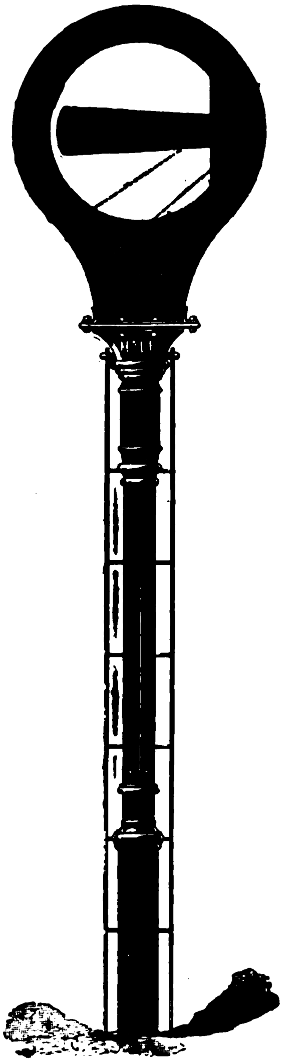


Fig. 1.—Hall Signal.

The object of this signal is to insure the delivery of orders to approaching trains. When the order is received, the operator throws the switch to the point marked "Danger," Fig. 2., thus opening the circuit and throwing the signal to "Danger," and this operation allows the drop in the indicator box to fall, which displays the words "Train Order," Fig. 4.

When the train is brought to a stand-still in front of the station, it is the first impulse of the operator to clear the track; he naturally moves his switch lever to the point marked "Safety," but the signal remains at danger, and in order to close the circuit, it is necessary for him to push the button on the annunciator, when he is confronted with the words "Train Order." This reminds him that he has an order for that train. He delivers the order, returns to the office, pushes the button on the indicator, closing the circuit, and causing the signal to drop to the point marked in dotted lines in Fig. 1. At the same time the annunciator is cleared. A complete train order station consists of signals to cover the track from opposite directions, as east and west.

It will thus be seen that should the operator forget that he has orders, once his signal is set, the train will stop and not proceed until he has closed the circuit at the indicator box where the drop reminds him what the train is detained for.

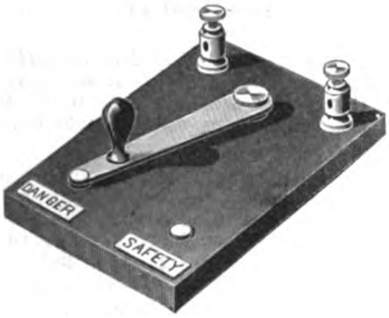
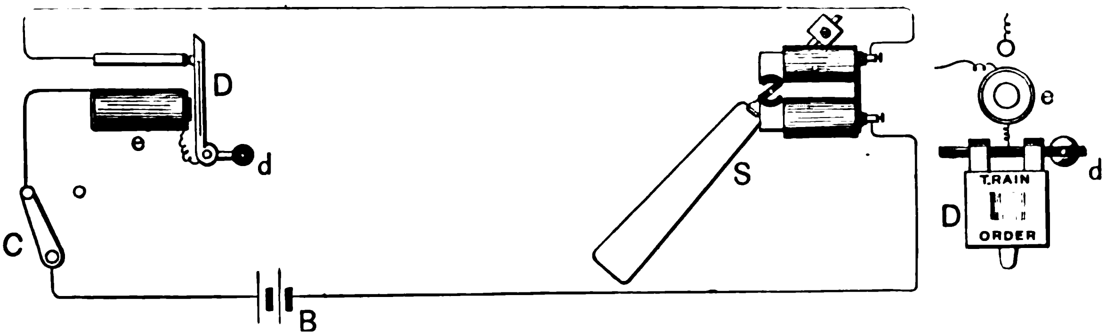


Fig. 2.—The Switch.

The value of this device will be apparent when it is considered that the person in charge of a small railroad station plays the role of telegraph operator, ticket seller, and baggage master, which, with the various details attached to each of these offices, makes him liable to commit serious errors.

There is probably no part of the duties of a station operator so liable to be overlooked as train orders, and where considerable time elapses from the moment he has received orders, and the arrival of the train for which they are intended, the danger of their being forgotten is increased. Many serious accidents have been occasioned by train orders being forgotten, but by the application of this system the station operator is relieved of the fear that he is liable to forget. The moment he makes the simple movement of a switch, he goes about his work knowing that everything will be attended to.



Figs. 4 and 5.—Diagram of Circuit, Stewart-Hall Train Order Signal.

While this appliance is intended for train order signaling, it may be used as a station starting signal, the drop in the station showing in all cases the position of the signal even should it be out of sight of the operator. It can also be used to advantage on many roads where an extensive system of signals is unnecessary.

THE TRICYCLE IN MILITARY TELEPHONY.

In a recent issue *La Lumière Electrique* described the employment in military telephony of a tricycle, adapted either for traveling on roads or for use as a water velocipede, without the necessity of undergoing any change in its mechanical construction. The wheels, instead of the usual pattern, are formed of three large hollow bi-convex discs of sheet iron, and thoroughly watertight. They are fitted with small copper floats, which, while not in the way for road work, act as paddles when the machine is afloat. The hollow wheels serve to support the construction on water. A small drum is carried, on which is coiled from 100 to 200 yards of a tinned copper conductor, insulated with gutta-percha and double braided. A small board, conveniently fixed, carries a portable telephone or a Morse sounder. The telephone is preferable, as it can be carried in the pocket, requires no regulation, and can be attached to the chin-strap of the helmet or other military head gear. For river or lake work one Leclanché cell is used, but on salt water the following type of cell is employed. Two small electric light carbons, connected metallically, are secured in grooves cut in the opposite faces of two pieces of cork. Between the carbons, and through the centre of the cork, a thin rod of zinc is passed, and to it is attached, by a wire, a copper plate. The carbons are connected to the instrument board. When required for work the cell is placed in the water. The speed attained with this tricycle has been on land from 9½ to 12½ miles, and on water from 2½ to 4½ miles per hour. It is said to work very easily, and experiments with it, recently conducted at Marseilles, are reported to have resulted very satisfac-

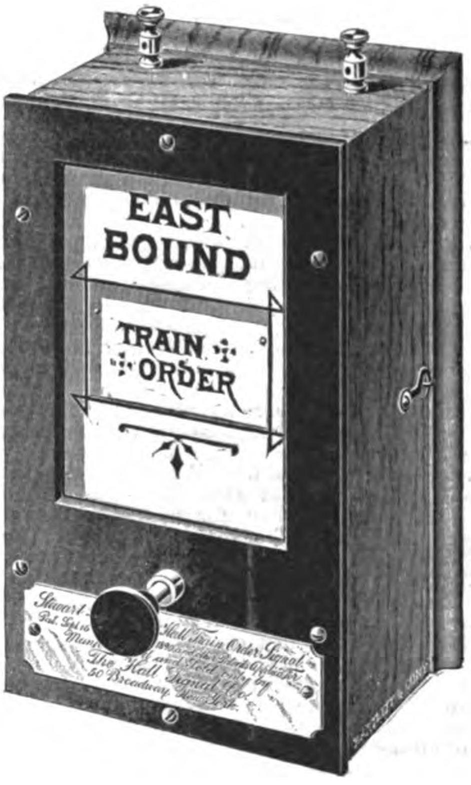


Fig. 3.—Train Order Signal.

torily. Its employment is described as likely to be of service to detached bodies of troops carrying with them no pontoons, possessing no means of fixing up a temporary bridge, and engaged on duties which render necessary permanent communications with headquarters.

Home Correspondence.

PITTSBURGH.

Electric Railway for Clarksburg, W. Va.—Electric Railway Work in Pittsburgh.—Taxing Street Railways.—Lighting at Uniontown, Pa.

A COMPANY has been chartered in Clarksburg, W. Va., for the purpose of building and operating an electric railway. The company is composed principally of the stockholders of the Clarksburg Electric Company, which is now operating an electric light and power plant in that city.

The transformation of the motive power on the different street car lines in this city from animal to electric power is still rapidly progressing. Unless something unforeseen occurs, two more electric street car companies will have started within the next two weeks. They are the Duquesne Traction Company and the Birmingham Traction Company. The former is now occupied with putting the last finishing touches to the overhead work on its many lines throughout the city. A number of the cars have already arrived; the power house has been finished for some time and the machinery has also been placed in position. Had it not been for the unfortunate snowstorm, which delayed everything a few weeks ago, the road would undoubtedly be in operation today; but as the effects of that have now also been overcome everything is being put into shape for the first car to be running within a very short time. The management of the Birmingham Traction Company has completed everything except to put the motors on the trucks when they will also be in a position to send their horses, which they are now still using, to pasture, and give their patrons rapid transit with electric motors.

Most of the Pittsburgh street car companies, especially those operated by electricity, are now dividend paying corporations and it appears that the city authorities think the city ought to have some of these large earnings. It is perhaps on that account that the city comptroller has lately addressed communications to the authorities of all the larger cities in the country for the purpose of obtaining from them information as to how much this city might be able to make from a taxation of the many electric, cable and other street car lines now running here. The comptroller has already received replies from Cleveland, Baltimore, Providence, R. I., St. Louis, Buffalo, Milwaukee, Newark, N. J., Cincinnati and Boston and from all of these it appears that Pittsburgh really is behind most cities in the way of getting revenue from its street car lines. As soon as the comptroller has heard from a sufficient number of cities to form an estimate of the whole, he will make his report to the city council and the result will in all probability be that street car companies in this city will also have to pay a tax.

The Heat and Light Company, of Uniontown, and the Electric Light and Power Company, of the same place, have formed a consolidation under a New Jersey charter and the new corporation will be known as the United Light Company.

The Second Avenue Electric Street Car Company has ordered four new cars to accommodate the increasing traffic of the road.

PITTSBURGH, Jan. 10, 1891.

Letters to the Editor.

THE DOUBLE WIRE SYSTEM DURING THE RECENT STORMS.

In your editorial of Dec. 31, 1890, page 723, you have, perhaps unintentionally, done injustice to the double wire system of electric traction.

The day after Christmas the entire State of Pennsylvania was visited by a most severe snow fall, varying in depth between 15 and 20 inches. At Sunbury the snow fell something over 20 inches during a continuous period of 17 hours. The road running between that town and Northumberland is built on the two-wire plan, and is equipped with the United Electric Traction Company's motors of the 1890 type, 30 h. p. each, geared to a single axle, only, for traction. The road includes a large number of very short turns and grades of over six per cent., two of them having sharp curves near the top. The road also labors under the disadvantage of having the trolley wire 18 feet high at the railroad crossing, while through the bridges it is so low that the trolley head goes within four inches of the trolley-boards on the roofs of the cars.

In spite of the fact that the local superintendent, Mr. Chase, had only just been put in charge two days before, and was not yet acquainted either with his employés or with the facilities of the town, he was able, with the assistance of Supt. Dodge, of the United Electric Traction Co., to open his line so that cars were running, though irregularly, throughout the day, and by Friday evening the cars were making through trips very nearly on time between the extreme limits of the road. This was done in spite of the fact that sand-boxes which had been ordered several weeks before had not arrived and they were obliged to make a slight use of sand from boxes standing on the front platforms.

Inasmuch as nearly all the single trolley roads throughout the country were snowed up, this is a particularly interesting record, and we feel sure that you will be glad to record it as a vindication of at least one double trolley system.

J. STANFORD BROWN,
United Electric Traction Co.

NEW YORK, Jan. 12, 1891.

Literature.

The No. XI. Pocket Handbook of Useful Information, Price List, Telegraph Code, etc. Relating to Lead Covered Electric Cables, Insulated Wires. etc. By Joseph W. Marsh. July, 1890. The Standard Underground Cable Co. Pittsburgh, New York and Chicago.

ALTHOUGH the electrical trades afford much scope and opportunity for the catalogue maker, the occasions are rare when trade publications call for more than a passing notice. We would, however, be lacking in duty if we failed to call to the attention of our readers the excellent pocketbook which lies before us, and which we are sure will occupy a prominent position among the handy volumes of the electrical engineer.

Underground work has reached such proportions in this country that a thorough knowledge not only of the materials, their qualities and various applications, but the manner of their laying has become a necessity to the electrical engineer. In the handy volume before us we find complete descriptions of the various types of Waring electric light, power, telephone and telegraph cables, both lead covered and armored, and for all classes of service, overhead, underground and submarine, together with their weights, thickness of insulation and the various other data which are generally required to be known in drawing up specifications. Upon all of these the well-known Waring insulating material is employed. In addition to this, however, we have full descriptions of the various other kinds of wire, rubber covered, bare, magnet and annunciator wire, etc., manufactured by the company, as well as the weather-proof line wire. On the latter the well known insulation "Ozite," or Waring compound, is employed. Each of these is accompanied by a description relative to its proper use and method of placing.

Regarding the mixture of tin with the lead covering of cables, we note that the manufacturers doubt the value of this application, though they are prepared to furnish the covering to any desired specification.

We also find some interesting records of experiments made to determine the self-induction of cables carrying alternating currents of 16,000 alternations per minute. In one of these tests the out-going and returning cables were placed in the same 3-inch iron duct; in the next the out-going and returning cables were placed in separate ducts. The total length of the cable in each circuit was 8,800 feet. In the former case it was proved that the loss due to self-induction per ampere per thousand feet of cable amounted to .06 volt, while in the second case the loss due to self-induction for the same length of cable was .0212 volt. From these experiments it would appear that when alternating currents are used, the out-going and returning cables should be in the same duct, which, indeed, is what theory would call for. To accomplish this in the best manner, a duplex cable is manufactured by the company in which both conductors are placed at a minimum distance apart.

We also find here full description of the Acheson electric light cable terminals, which allow of ready testing and for connecting the cable with pole line or lamps, and the Acheson cable protector, both of which are very fully described and illustrated. The Degenhart hard rubber terminal is also illustrated and described

One of the most valuable parts of the work is unquestionably that relating to the working directions for placing, splicing and laying electric cables. Here we find full directions for the laying of conduits either in the open box or cement-lined tube, the location of manholes and handholes, the operation of drawing cables into closed conduits and the tools required therefor, the laying of submarine cables, the stringing of aerial cables, house cabling and wiring, etc., and complete directions for making joints of all kinds and those specially adapted to the Waring cables. In short, the information given in this respect is so detailed and complete that, with a little experience, first-class work in this department ought to be accomplished with ease. To this are added very succinct rules and methods for testing electric cables, the locating of faults, grounds and crosses, etc., and the determination of insulation and capacity.

To all this valuable information there is added a chapter of general and electrical information showing the size of wires, comparison of wire gauges, electrical units, wiring formula and tables, and short rules for determining the sizes of conductors. Among these we find a very valuable table on the carrying capacity of cables, taking into account the heating effect and the various conditions in which they are used; and finally an electrical horse power table by which, when the ampere and voltage is known, the power can be read off at once.

The volume closes with the standard rules adopted by the New York Board of Fire Underwriters and various electrical statistics relating to central stations, isolated plants, electric railways, telephones, etc.

From the above it will be apparent that the work is one which reflects great credit upon the Standard Underground Cable Company and should be in the hands of every electric light, telegraph and telephone superintendent. We are not informed as to the size of the edition printed, but we make bold to say that a second edition will soon be in order.

Reports of Companies.

SECOND ANNUAL REPORT OF THE EDISON GENERAL ELECTRIC CO.

THE second annual report of Edison General Electric Co. was presented at the meeting of the company, held in this city on Monday, January 19, and in view of the circumstances of the past year and the immediate moment, is a most remarkable and encouraging document. It begins with a statement of the reorganization of the Edison industries, consummated in the centralization of a strong management and control, with a system of District agencies. For the success of this onerous and complicated work of reconstruction and amalgamation great credit is given in the report to Mr. Samuel Insull, second vice-president, and Mr. Joseph P. Ord, the comptroller. Reference is also made to the fact that it early became necessary to increase the manufacturing plant and working capital, in order to keep pace with the growth of the business, and to the fact that for the $2,000,000 then raised by the Sprague Co. the lenders are taking the stock of the General Co., whose capital stock was raised on Monday from $12,000,000 to $15,000,000. Of this sum, $1,000,000 remains in the treasury. The net earnings of the business were over 8 per cent. on the total stock, and this year the stock held under trust agreement by the Farmers' Loan and Trust Co. also becomes dividend bearing, beginning with the 2 per cent. payable February 1. The gross profits of the year, after deducting $266,071.27 set aside for depreciation of the plants of the several works, and $206,679.15 for general expenses, without including the royalties received by the Edison Electric Light Company, amounted to $1,896,177.06. From this sum various other amounts have been written off, as shown below. The 6½ per cent. deduction for depreciation was made on the entire plant, notwithstanding additions of $949,274.70 (or about 23¼ per cent., to the property accounts of the manufacturing plants) during the year, on which no appreciable depreciation could have taken place.

The General Company owns practically all of the capital stock of the Edison Electric Light Company, and therefore its profits should in point of fact be considered as part of the General Company's resources. From the statement of the Light Company, it appears that its net receipts during the fiscal year were $1,023,011.29 in cash and stocks and bonds of licensed local companies. In accordance with the policy which the Light Company has always pursued, this sum, together with stocks and bonds formerly acquired, is held in its treasury undistributed.

At the close of the previous fiscal year, there remained a balance of $679,401.48 to the credit of profit and loss on the General Company's books. The gross profits of the General Company during the year under review bring the total up to $2,782,257.69. From this there have been deducted $206,679.15 for general expenses; $100,000 charged off against patents; $614,711.41 charged off against cost of acquisition of stocks of sub-companies whose business has been consolidated into the company; and $665,314. for dividends distributed; after which there remains $1,195,553.13 carried into the new year to the credit of profit and loss. This sum does not include the business of the Light Company as above set forth.

The balance sheet of the General Company, dated October 31, shows that the quick assets, consisting of cash, bills receivable and accounts receivable, amount to $3,619,063.59, while the entire liabilities of the corporation, other than those to its stockholders, amount to only $2,647,828.41. Adding to the quick assets above stated, the sum of $4,272,903.63, which represents amounts expended on contracts in course of completion, and materials on hand and in process of manufacture, the active working capital of the company over and above its liabilities, appears to be about five and one-quarter millions of dollars.

All materials in stock and in process of manufacture are carried at net invoiced prices. The materials and expenditures on uncompleted work in progress are carried on the books at cost, and without any allowance for profits. This should be kept in mind in considering the value of the total of $4,272,903.68 above referred to.

Some condensed figures are also given in the report as to the magnitude of this united industry now bearing the name of Mr. Edison, with whom it is stated, by the way, that a new contract for experiments and inventions has been entered into. The company now has 6,000 employees on its pay rolls, and the transactions of the past year aggregated $10,000,000, while the current year opened with orders enough on hand to run the full force for a period of six months. In the special field of light and power from large central stations, a great development is taking place. In New York City a station, with a maximum capacity of 200,000 lights, the largest in this country, is being erected by the local company, and new stations of large capacity are going up in Brooklyn, Chicago, Milwaukee and Cincinnati. The local Edison Companies obtain their entire electrical plant and additions thereto, including apparatus and fixtures of every kind, from the works; and every new station therefore results in a large, new and ever-growing business. According to the official record, there were in operation on November 1, 1890, within the territory of the United States and the Dominion of Canada, large and small Edison stations representing an aggregate capacity of 1,371,000 lamps. In the Railway Department there was also greatly increased activity. The Sprague car motors sold in 1889-90 represent an aggregate of 27,679 horse-power, and the generators (dynamos for traction current) 22,836 horse-power, as compared with motors of 10,680 horse-power and generators of 7,665 horse-power in 1888-89.

There was expended during the year a total of $949,274.70 for new buildings, new machinery and other additions to the permanent plants. Of this amount $777,752.64 was invested in the works at Schenectady, and includes the cost of buildings and a portion of machinery for the manufacture of Siemens & Halske's patent underground cables from which large profits are expected. The new investments have more than doubled the capacity of the Schenectady works, and the number of employees was increased from 1,700 to 2,900, while the total product manufactured and sold shows an increase of 117 per cent. over the preceding year.

The enlargement of the lamp works, at East Newark, N. J., called for an outlay of $100,000, which will increase their capacity from a daily output of 11,000 lamps to 25,000 lamps. "The reduction in the price of its lamps, which this company was able to make two months ago in consequence of economies in their manufacture, for which it is indebted to the ingenuity of Mr. Edison, has already more than doubled its orders." The sales of lamps increased 64 per cent. over the previous year. The number of employees rose from 379 to 605.

The business of the New York works, formerly known as Bergmann & Co., increased 31 per cent. and the employees from 704 to 895. The growth of the Canadian business has made it necessary to abandon the shop at Sherbrook, P. Q., for new and larger works now being erected at Peterborough, P. O. The present force of 204 men will then be transferred from Sherbrook and largely increased.

It will be remembered that during the past year, the company created no small sensation by its reductions in the price of apparatus. There has been considerable curiosity to see whether the policy would be maintained. The report says on this subject: "It will not be out of place to mention in this connection that, as the best means of enlarging its business and meeting competition, the management of the company is steadily pursuing the policy of reducing the cost to customers while improving the standard of its products. In this endeavor the management is constantly seconded by the unceasing activity of Mr. Edison, and by the intelligence, skill and experience of a number of its officers and employees. The difference between the present manufacturing methods at our works and those of a few years ago, shows how great is the progress that has been made. A striking illustration is the reduction in the cost of our incandescent lamp."

The following were the trustees elected at the meeting, the name in italic being the only new one: C. H. Coster, T. A. Edison, *J. B. Williams* (vice-president, Northern Pacific R. R,), J. H. Herrick, Samuel Insull, Edward H. Johnson, A. Marcus, Carl Schurz, F. S. Smithers, H. Villard and J. Hood Wright. The executive officers are: President, H. Villard; vice-president, J. H. Herrick; second vice-president, S. Insull; secretary, A. Marcus; treasurer and assistant secretary, F. S. Hastings; assistant treasurer, A. S. Beves; comptroller, J. P. Ord.

AMAGANSETT TEL. & TEL. CO.

The annual meeting of the Amagansett Telegraph and Telephone Co., recently held at Amagansett, was very enjoyable to shareholders, as some 20 per cent. was reported as the dividend for this the first year's earnings. The following directors were elected: Benjamin H. Barnes, George C. Hand, J. Mason Schellanger, Capt. Joshua H. Edwards and William C. Cartwright.

AMERICAN BELL TELEPHONE CO.

The Bell telephone directors at their meeting in Boston on January 14, authorized the issue of $2,500,000 new stock April 1. This would give one new share for five outstanding, and will increase the capital stock to $15,000,000. A special meeting of stockholders will be called for Jan. 27, to act on the recommendation of the directors for an issue of new stock.

CHANGE OF OFFICERS OF THE COMMERCIAL CABLE COMPANY.

Mr. George G. Ward has been elected vice-president of the Commercial Cable Company, in place of Mr. Hector de Castro, resigned. Mr. Ward now occupies the dual position of vice-president and general manager. Mr. Chas. R. Hosmer, the well known and able manager of the Canadian Pacific Telegraphs, has also been elected a vice-president of the company. Mr. J. O. Stevens is now secretary and Mr. Albert Beck assistant secretary of the company.

EDISON ILLUMINATING CO., OF NEW YORK.

The Edison Electric Illuminating Company, of New York, in a statement to the New York Stock Exchange in connection with the application to list $1,000,000 additional capital stock, which was granted by the Governing Committee, makes the following comparative statement of earnings:

Years.	1888.	1889.	1890.
Gross	$226,301	$327,678	$488,595
Op. exp. and taxes	110,066	203.647	259.517
Net	$116,235	$124,031	$229,078

These earnings do not include any revenue from the large station on Pearl and Duane streets, now in course of erection, or from any considerable part of the additions and extensions recently made to the company's system throughout the city.

AFFAIRS OF THE WESTINGHOUSE CO.

A dispatch from Pittsburgh, Pa., of Jan. 15, says: The announcement this morning that the Advisory Board appointed by bankers and business men of this city to look into the affairs of the Westinghouse interests with a view of loaning the various concerns in need of assistance $500,000 to carry them through their present financial difficulties had returned the checks, notifying the subscribers that it would not be advisable to use any of the fund, occasioned no surprise, as the action had been expected for several days.

Two suits have been entered against the Westinghouse Electric Co. for small amounts. One was by the Keystone Bank, of Erie, Pa., for $2,000, and the other by Park Brothers & Co., steel manufacturers of this city, for $800.

A HOPEFUL VIEW OF THE WESTINGHOUSE TROUBLES.

Thirty creditors were present at the meeting of the creditors of the Westinghouse Electric Company on Jan. 17, at Pittsburgh. This is about one-fourth of the number. W. B. McLean presided, and as a result of the creditors' committee examination it was announced that the Pittsburgh creditors represented $147,500, and the outside creditors $300,000. Vice-President Bannister stated the company was doing well, and would soon be on a paying basis.

A telegram from a Chicago creditor representing $2,500 was received saying he would take it all in preferred stock. It was stated that the committee's examination of the books up to July 15 showed a daily business average for the last quarter of $15,000. Mr. Bannister said that, with proper management, the company would be worth $600,000 in annual profits to the creditors.

A proposition for creditors to accept preferred stock, instead of cash, was read, the signatures to be binding if 60.000 shares at $50 par value, or $3,000,000 worth, were disposed of.

Mr. Westinghouse was present, but was represented by H McL. Harding, who is in charge of the railroad department. He explained the situation from Mr. Westinghouse's standpoint, and said that lately they had cut down expenses to the extent of $600,000 a year. Not all of the creditors present were then prepared to sign, but those who did so took $65,000 of the preferred stock, and $25,000 more was promised.

Mr. Westinghouse was seen, and said that his efforts in New York to place preferred stock had been very satisfactory, and the stock taken there and at Pittsburgh had put a most favorable aspect upon the situation. He said he had there secured a subscription for four thousand shares by one interest, that he could answer for another four thousand, and that negotiations there were well advanced for placing twelve thousand five hundred shares more.

He also thought that under the present condition of things there was no reason why the retirement of the Advisory Board should have more than a momentary effect. He returned to New York on Sunday night.

THE UNITED ELECTRIC TRACTION CO.

The United Electric Traction Co., at 115 Broadway, has been levied on by the sheriff, on attachments aggregating $1,600 and a judgment for $804. The company is said to have been asking extra time on maturing obligations recently, and the total amount of unsecured indebtedness is said to be $150,000, while it is understood to have large assets. Leo Daft has brought suit against the company, the Daft Electric Light Co. and others to recover $50,000, and to set aside a contract relating to the exchange of stock of the Daft Company for that of the United Electric Traction Co., and to recover property of the Daft Company from the United Company. This suit may be discontinued.

It is declared by the officers of the United Company that its financial condition is being substantially strengthened.

The United Electric Traction Co. was incorporated in March, 1890, in New Jersey, with an authorized capital stock of $7,000,000 of which $5,000,000 was common stock. A large part of the latter was issued for the stock of the Daft Electric Light Co. and the Electric Power Co., of New York, and the right to use patents on storage batteries of the Julien Electric Co., the Julien Electric Traction Co. and the Brush storage battery. It assumed debts of the Daft Co. and of the Electric Power Co. amounting, it is said, to $400,000, and guaranteed $100,000 bonds of the Julien Electric Traction Co. It was said to have received from the Daft Co. tangible property worth $1,000,000, not including patents.

The company has been mainly developed by R. L. Belknap, ex-treasurer of the Northern Pacific Railroad, and Dr. John C. Barron. Mr. Belknap was its president until December last, when he was succeeded by J. Edward Ackley. In the same month the company gave a chattel mortgage of $700,000 to the Mercantile Trust Company to secure bonds.

STOCKS AND BONDS.

Wilson, N. C.—The town has issued $75,000 worth of bonds, $25.000 of which are for the erection of an electric light plant. G. D. Green, mayor, can give information.

Knoxville, Tenn.—The Knoxville Schuyler Electric Light Co. has issued $20,000 worth of bonds for the purpose of enlarging its electric light plant.

Hyde Park, Mass.—The Hyde Park (Mass.) Electric Light and Power Co. has placed on record in the town clerk's office a mortgage to the International Trust Co., of Boston, of all their property, both real and personal, to secure the payment of gold bearing bonds to the amount of $75,000, to be run 30 years at 5 per cent. interest. It is said to be the largest mortgage on local property ever recorded in that town. The local plant, it is said, has passed into new ownership, capitalized at $100,000.

ELECTIONS.

Bucyrus, O.—The Bucyrus Gas and Electric Light Company, at their annual meeting elected J. B. Gormly, W. C. Lemert, C. W. Fisher, G. C. Gormly and F. P. Kaler directors. This is the exact roster for the past year, and the organization will no doubt remain the same.

Newport, O.—The Suburban Electric Heat and Power Company has elected the following directors for the ensuing year:—H. M. Healy, Paris C. Brown, Jos. Feth, John P. Newman, A. M. Worthington, Harry Buchanan, Jr., and Chas. J. Helm.

Society and Club Notes.

BOSTON ELECTRIC CLUB DINNER.

The first dinner of the Boston Electric Club under the new administration was held on Friday evening at Young's Hotel, Boston, at which about 42 members were present. In the absence of Capt. Griffin, who was unfortunately detained by sickness in his family, Mr. C. J. H. Woodbury, one of the vice-presidents, presided, and after dinner introduced the various speakers. Speeches were made by Messrs. H. B. Cram, Col. Ransom, R. F. Ross, G. W. Mansfield, Dr. Austin, W. D. Warner, W. J. Denver, Mr. Thos. Goodrich, vice-president of the Niagara Insurance Co., of New York, and Mr. W. N. Colham, of London (who was a guest of Mr. Mansfield), and a member of the Civil and Mechanical Engineers' Society. Mr. Colham spoke particularly of his trip through the United States, and described in some detail the use of electricity in the operation of the underground railway in London. Some suggestions as to the future conduct of the club were made, Mr. Mansfield suggesting that the club be made a sort of hotel instead of an exclusive club. A most enjoyable evening was spent, and hopes were entertained that these entertainments would be held regularly every month.

Mr. F. L. Pope lectures before the Electric Club on Thursday evening on electric railways.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JAN. 13, 1891.

Alarms and Signals :—

Electrical Sporting-Indicator, S. D. Mott, 444,452. Filed June 19, 1890.

A signaling apparatus and electrical circuits to indicate visually at a distance the varying conditions of any sporting event, such as a ball game, a horse race, or the like. A number of indicators, at different points, may be connected upon a single circuit and operated from a given point, as from the grounds or track where the event is in progress.

Electrical Sporting-Indicator, S. D. Mott, 444,453. Filed June 19, 1890.

Development and amplification of No. 444,452 above.

Racing-Indicator, S. D. Mott, 444,454. Filed Aug. 7, 1890.

Special adaptation of the inventor's system to indicating at any desired point the movements of horses upon a race-track.

Clocks :—

Independent Electric Clock, E. G. Hammer, 444,433. Filed May 24, 1890.

An electro-magnetic apparatus is employed to wind the spring at intervals, and also to perform the mechanical work of advancing the hands or other indicating devices of the clock upon the dial to denote the time. A circuit-closer, operated by the escapement, admits current to the electro-magnet once each minute or at other predetermined intervals.

Electric Hand Setting Mechanism for Clocks, W. W. Bradley and W. N. Packer, 444,482. Filed March 28, 1890.

Claim 1 follows:

The combination, with a synchronizing-clock, of a magnet or a pair of magnets which when charged will first set the seconds-hand and then set the hour and minute hands.

Conductors, Conduits and Insulators :—

Conduit for Electric Wires, A. P. Wright, 444,477. Filed April 18, 1890.

A conduit for interior wiring. It consists of a number of short tubes having the inner diameter enlarged at the ends, each independent of the other and connected end to end by flexible tubing.

Conduit-Inspector, J. L. Blackwell, 444,687. Filed Aug. 9, 1888.

An apparatus for facilitating the examination of the interior of underground conduits of electric railways. The inspecting device adapted to be carried along through the conduit by a projection extending through the slot, includes an electric lamp and a mirror suitably arranged to illuminate the interior and disclose its condition.

Distribution :—

Electric Indicator, J. Hopkinson, 444,552. Filed Feb. 23, 1889.

Consists of elements and combinations of apparatus for carrying out the method covered in Patent No. 444,553 below.

Method of Controlling Currents upon Electric Circuits, J. Hopkinson, 444,553. Filed Feb. 23, 1889.

A method for determining the variations of potential, at a given point in a system of distribution, whereby the varying drop or loss of potential may be readily compensated for all times; specially applicable to constant-potential distribution. Employs an electro-magnetic indicator, wound with two opposing coils, one of high resistance connected across the terminals of the source of electricity, and the other of low resistance so connected as to be traversed by all or a determinate portion of the current flowing through the translating devices. The differential action of the apparatus may be made to indicate the relation between the difference of potential required at the terminals of the source and the amount of current flowing to the work circuit.

Dynamos and Motors :—

Electric Motor, W. A. Anthony, 444,416. Filed May 14, 1890.

Relates to the windings of field magnets; and consists in winding a field magnet with an ordinary shunt-wire for its magnetization at all times when the motor is running, and in the additional winding upon the same magnet of a separate wire, the function of which is to interpose a large but gradually decreasing resistance between the main line conductor and the armature when the current is first turned on, and also to supplement the magnetic effect of the shunt-wire when the motor is started and until the motor has attained its full speed, when the resistance wire is cut out.

Dynamo-Electric Machinery, J. B. Entz, 444,486. Filed July 10, 1890.

A design and arrangement of field magnets and pole-pieces. The field magnet consists of a single coil of wire wound upon an elliptically-shaped coil; an extended forked pole-piece passes from end of the coil around the sides of the magnet to the other end forming two poles of like polarity, while a shorter forked pole-piece attached to the other end of the coil forms two poles alternating in position with the two first named.

Regulator for Dynamo-Electric Machines, R. E. Ball, 444,587. Filed Feb. 26, 1860.

Dispenses with mechanism such as is usually employed for the automatic shifting of the brushes upon the commutator, by changing the position and shape of the yoke carrying the brush holders, making it of magnetic metal, as iron, and so adapting its shape and position that it shall automatically shift the brushes for regulation under the influence of the variation in the number of magnetic lines of force passing through it from the field magnets.

Brush for Dynamos, A. S. Cook, 444,794. Filed Mar. 28, 1890.

Claim follows:

A carbon brush for dynamos and motors, the pores of which are filled with oil.

Ignition.

Electric Gas-Lighter, T. W. Lane, 444,706. Filed June 18, 1889.

Improvement in the class of lighters known as "automatics." Claim 1 follows:

In an automatic electric gas-burner, a rotary gas-cock attached to a ratchet-wheel, and a pawl so connected with or operated by the armature as to admit the gas at its complete depression and thereafterward admit of a series of partial vibrations of the armature without withdrawing the pawl entirely from the tooth of the ratchet during pressure on the button.

Lamps and Appurtenances :—

Electric-Light Support, A. Dawes, 444,424. Filed Jan. 29, 1890.

An adjustable-arm support for incandescent lamps.

Electric-Lamp Bracket, T. C. Smith, 444,466. Filed May 19, 1980.

A design and construction of a bracket for incandescent lamps, especially for street lamps.

Carbon for Arc Lights, B. B. Ward, 444,471. Filed April 4, 1890.

A carbon designed to obviate hissing and sputtering. The carbon has a longitudinal bore or passage, the walls of which are coated with a thin film of a silicate—as for example, silicate of soda.

Electric-Arc Lamp, B. B. Ward, 444,472. Filed April 11, 1890.

Relates particularly to automatic safety devices for arc lamps and designed to prevent injury in case of abnormal variations in the length of arc; provides means by which the current may be shunted around the lamp while at the same time the coils of the regulating derived-circuit magnet may be protected from injury.

Electric-Arc Lamp, B. B. Ward, 444,473. Filed April 11, 1890.

Relates to the disposition of parts, such as lamp-hood, artificial resistances, etc.

Claim one follows:

The combination, with an electric-arc lamp, of a lamp hood, a chimney for the arc lamp, and an artificial resistance-frame mounted in the chimney of the hood independently of the lamp and provided with a vertical passage or opening to receive the lamp-chimney.

Incandescent-Lamp Socket, G. R. Lean, 444,567. Filed March 27, 1890.

Design and construction for cheapness and efficiency. Block and holder engage by a bayonet joint.

Leading-in-Wire for Incandescent Electric Lamps, T. A. Edison, 444,530. Filed Sept. 15, 1890.

Intended to economize the amount of platinum employed for leading-in-wires. The leading-in-wires are made in sections, one section being of platinum or other metal whose coefficient of expansion is substantially the same as that of glass; the platinum or other similar metal is included in that portion of the leading-in-wire which is sealed into the glass.

Claim 1 follows:

An incandescent electric lamp having leading-in-wires composed of sections of different metals, one of which sections is of a metal whose coefficient of expansion is substantially the same as that of glass, the other of a metal which has a different coefficient of expansion, and both of said sections being sealed into the glass.

Measurement :—

Phase-Indicator for Alternating Electric Currents, C. S. Bradley, 444,791. Filed June 23, 1890.

Claim 1 follows:

An indicator for showing a difference of phase in two or more alternating currents, comprising a synchronous electric motor operated by one of said currents and a magnetic device controlled by another of said currents, said device co-operating with a rotary element driven by the synchronous motor and adapted to be angularly displaced when corresponding phases of the two alternating currents are not simultaneous.

Potenital-Indicator, E. Weston, 444,803. Filed June 5, 1890.

An instrument for showing variations in potential of a current maintained on a circuit or for indicating electrical pressure in volts. Consists, substantially of two coils connected in circuit and having their longitudinal axes in prolongation, one of the coils being both rotary on its axis and movable with respect to the other coil, near which it is placed in inductive proximity, and a means for indicating the extent of rotation of the movable coil; a translucent scale plate is employed for the indication.

Electrical Measuring Instrument, E. Weston, 444,804. Filed June 11, 1890.

An instrument for the same purpose as that of No. 444,803. above, and similar in principle, but employing two fixed coils and a movable coil.

Electric Measuring Instrument, E. Weston, 444,805. Filed Oct. 18, 1888.

For measuring the electromotive force of electric currents in volts. Consists of an apparatus in which an electrical conductor in loop form is supported in the field of force of a magnet and is free to move bodily in such field under the influence of the current traversing the loop. The motion of the conductor is opposed and equilibrated by a spring, the extent of its movement being shown upon a scale.

Medical and Surgical :—

Electric Magnetic Massage-Kneader, D. Lichtenstadt and C. Lichtenstadt, 444,597. Filed Dec. 8, 1890.

Consists in a kneader provided with electric elements, which are adapted to be rolled over the surface to be treated, and a magnetic bar supporting such elements.

Electric Appliance for Trusses, A. Owen, 444,599. Filed Oct. 11, 1890.

An insulating truss-pad is provided with an adjustable and movable metal cap having means for connecting with it a conductor.

Miscellaneous :—

Rheostatic Switch, J. H. Lehman, 444,707. Filed Mar. 8, 1890.

Claim 1 follows:

In an electric switch, a resistance device consisting of blocks of plumbago and potters' clay separated by discs of platinum, the discs being connected with separate contact plates, and standards supporting the resistance device.

Voltaic Insole, M. E. Thomas, 443,735. Filed Nov. 6, 1890.

Insole has electrodes suitably arranged and connected with each other, the perspiration from the foot being depended upon to excite electric currents.

Lightning Arrester, E. Thomson, 444.678. Filed March 17, 1890.

Consists, broadly, in constructing a lightning arrester or discharger with a succession of striking spaces in series and in making the sum of the striking spaces several times greater than the space which would be given to an ordinary lightning arrester, or between the plates of a single break lightning-arrester. The inventor prefers that the metal pieces interposed between each successive break should have some capacity for static charge, as this facilitates the successive breaking down of the disruptive spaces by a lightning discharge or sudden static effect.

Electric Elevator, N. P. Otis and R. G. Smith, 444,640. Filed Jan. 31, 1890.

Claim 1 follows:

The combination, with the electro-motor of an elevator, of a current-controlling device constructed to both reverse and vary the current and provided with a switch, means for automatically turning the switch to its normal position with the current cut-off, and means for operating said switch from the cage to carry it from its normal position in either direction.

Railways and Appliances :—

Electric Trolley, C. A. Lieb, 444.447. Filed Nov. 28, 1890.

For electric railways. The groove of the trolley is provided with a yielding or elastic surface supported upon a spring or springs or equivalents.

Electric-Car Controlling Device, E. M. Bentley, 444,479. Filed July 10, 1885.

Comprises a speed changing mechanism, by which the ratio of speed between the armature and driven axles may be changed, and a regulator for the motor and brake for the car which are controlled by the same operating lever which brings the variable gear into and out of action.

Electric Railway Car, E. M. Bentley, 444,480. Filed Sep. 8, 1888.

Includes a regulating device for the motor and a brake for the vehicle, controlled by a common actuating device, so that they shall be operated simultaneously.

Electric-Locoomtive, M. Waddell & J. B. Entz, 444,512. Filed May 20, 1890.

Relates to the manner of mounting an electric motor upon a car truck, with a view of relieving excessive strain at the time of starting or whenever the motor shaft tends to a sudden relative movement; the field magnet structure and frame is mounted in such a manner that it is free to rotate slightly on its axis when under severe strain, being loosely mounted upon an axis and connected to a strong spring with a rigid portion of the truck.

Electric-Railway Car, L. A. McCarthy, 444,589. Filed Sept. 3, 1890.

Relates to the method of transmitting motion from the armature shaft to the car axle. Driving rods, upon cams mounted upon the ends of the armature shaft are used in conjunction with friction pulleys, in place of the gearing usually employed. A single motor hung midway of the length of the car is thus joined to both axles.

Current-Collecting Device for Electric Railways, R. M. Hunter, 444,566. Filed Aug. 12, 1890.

The trolley is mounted at the end of a rearwardly-extending part jointed to the upper end of the trolley pole so as to have freedom of lateral motion, and extending parallel with the trolley wire.

Automatic Signal for Railway-Crossings, A. W. Hall, 444,700. Filed July 26, 1890.

An apparatus for indicating to the trainmen whether crossing gates are open or closed.

Electric Railway, E. M. Bentley, 444,740. Filed July 10, 1885.

A turn-table or transfer-table for electric railways, applicable to roads operated by underground conductors.

Telephones and Appliances:—

Device for Inserting Branch Lines on Mechanical-Telephone Lines, G. F. Shaver, 444,461. Filed March 22, 1890.

For inserting branch wires at right angles with the main trunk line of a mechanical telephone line so that speech may be transmitted from one to the other without loss of power or impairment of articulation.

Mechanical-Telephone Exchange, G. F. Shaver, 444,462. Filed May 1, 1890.

Details of mountings or supports for mechanical telephones.

Mechanical-Telephone Exchange, G. F. Shaver, 444,463. Filed May 6, 1890.

A number of diaphrams and connected line wires are mounted upon and combined with a common sounding board.

Molecular Sound Resonator, G. F. Shaver, 444,464. Filed May 12, 1890.

Claim 2 follows:

The combination of two metallic resonators connected one with the other by means of a jointless metallic conductor.

Magneto-Bell, W. R. Patterson, 444,600. Filed May 27, 1890.

Relates to the class of electric bells in which the mechanism is placed within the box and the gongs and hammer outside, such as are used in the telephone service. Consists generally of mounting the gongs upon adjustable plates pivoted to the metallic frame which supports the magnet, the construction being such that the adjustment of these plates would be unaffected by changes that may take place in the wooden boxes.

Telephone Enunciator or Indicator, G. R. Lawrence, 444,780. Filed April 10, 1890.

An electro-magnetic and mechanical apparatus including a clock dial, designed to indicate automatically to a person sending a telephone message, in the absence of the person to whom the message is sent, the exact time the person called may be reached to receive the message, and for other similar purposes.

Legal Notes.

MONTREAL TELEGRAPH CO. vs. GREAT NORTH-WESTERN TELEGRAPH CO.

The directors of the Montreal Telegraph Company have presented their annual report. It chiefly refers to an action entered against the company by the Great North-Western Telegraph Co., on January 31, in the Superior Court, for a reduction in the rate of dividend payable under the conditions made in the agreement of Aug. 11, 1881, a reduction from 8 to 6 per cent. and also for another demand filed on September 26, 1889, for a further reduction of 2 per cent. with the exception of costs for proof. Both these actions had been dismissed. The G. N. W. had appealed to the Court of Queen's Bench, with the result that the ruling of the Superior Court had been sustained. The G. N. W. is now appealing to the Supreme Court of Canada against the judgment rendered against it. The balance of quarterly instalments paid since 1889 by the G. N. W. is deposited in the Canadian Bank of Commerce, awaiting the result of the suit. The amount of these balances are $70,000 with four per cent. interest.

A STORAGE BATTERY SUIT OF THE FORT WAYNE CO.

The Fort Wayne Jenney Electric Light Co. for the use and benefit of the M. W. Simons Electric Light Co. has begun suit for $20,000 damages against Abner Crossman, Samuel Heavenrich, Simon Heavenrich, Louis Mendelssohn, Hugo Hill, Isaac Mendelssohn and Sigmond Simon. It is claimed that the plaintiff corporation on June 27, 1889, contracted with the Pumpelly Storage Battery Co., of which the defendants were stockholders, to manufacture, at Plymouth, Ind., storage batteries until June 30, 1892. The Pumpelly Co. were to pay 20 per cent. above manufacturers' cost for the first 50,000 cells and 15 per cent. for all over that number. If the orders were less than $10,000 the Jenney Co. was to be paid for the expense of the plant. Isaac Mendelssohn did not sign the contract. The Jenney Co. sue for an alleged violation of the contract for the benefit of the M. W. Simons Electric Co., to which the contract has been assigned.

THE POWERS OF TOWN CORPORATIONS IN MASSACHUSETTS.

The full bench of the Supreme Court has sent down a decision holding, in the case of Willard Spaulding against the town of Peabody, that the committee of the town will be restrained from proceeding to establish and construct an electric light plant for the use of the town. The court says: "We assume that the Legislature by statute can confer upon towns authority to construct and maintain works for the manufacture and distribution of electricity to be used by the towns and their inhabitants for illuminating purposes. The question now presented is whether the existing statutes confer any such authority, either for the purpose of lighting the streets of towns or for this and the additional purpose of furnishing light to their inhabitants at reasonable rates. Such authority is not within any of the customary powers which towns from very early times have exercised, and must be derived, if it exists, from the statutes relating to towns."

ALUMINUM. — COWLES CO. vs. THE PITTSBURGH REDUCTION CO.

In the United States Circuit Court at Pittsburgh, on Jan. 17, Attorney M. W. Woodward filed papers in a suit for infringement in behalf of the Cowles Electric Smelting and Aluminum Company, of Lockport, N. Y., against the Pittsburgh Reduction Co. Infringement is claimed on four patents, described as "improvements in electric processes of smelting ore for the production of alloys, bronzes, and metallic compounds"; "an electric furnace and method of operating the same," and two improvements on the furnace. The Cowles Company claims that these patents, taken out in 1885 by Eugene and A. H. Cowles, are being used and operated by the Pittsburgh Reduction Company for the purpose of making aluminum and alloys.

G. H. Clapp, of the Pittsburgh Reduction Company, said: "Some time ago the Cowles people wanted to effect a consolidation with our company and build a big factory at Niagara. We had no use for their company, and we told them so. Our own patents are much more valuable and better adapted to our use than theirs. The process we use is not an infringement on the Cowles patent. They make only alloy; we make pure aluminum. They depend upon the heat produced by electricity, while we depend upon the action of the electric current."

RUTLAND, VT.—Suit has been entered against the Marble City Electric Light and Power Co., of Rutland, Vt., by the Brush Electric Co., of Cleveland, O., for infringement on its double carbon arc lamp patent.

TOLEDO, O.—Evidence has lately been taken at Toledo in the suit of the Brush Electric Co. against the Western Electric Co., for infringement of the double carbon arc lamp patent.

College Notes.

LECTURES AT COLUMBIA COLLEGE.

The course of evening electrical lectures at Columbia College has begun with every prospect of success. The popularity of the course is shown by the fact that there have been 20 applicants already more than the capacity of the room. There are 92 seats and 92 season tickets were sold. This is quite remarkable in view of the fact that there has been no advertising of the course, and that attention has been drawn to it only by brief notices in the newspapers.

Appointments, Etc.

MR. D. A. PALMER, of Chicago, has been engaged to manage the telephone system in Duluth.

DR. H. W. WHITMORE, has been elected secretary of the Citizens' Electric Light Co., of Akron, O., in place of S. E. Phinney.

MR. J. PARLETT of the Urbana telephone exchange, has resigned, to become night manager for the W. U. at Dayton. He will be succeeded as manager at Urbana by Mr. H. Huffman, of Columbus, on January 15.

MR. P. A. UNDERWOOD, of the Nantucket, Mass., Electric Light Co., has left the Island and severed his connection as superintendent. He is succeeded by Mr. John R. Bacon, of the Steamboat Co.

MR. J. R. MCKEE, son-in-law of President Harrison, has, it is stated, formed a business connection with the Thomson-Houston Electric Co.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

> *"The advertisement should be characterized by all the freshness and attractiveness of a personal interview."*

ALMOND'S FLEXIBLE METAL TUBING FOR BRACKETS AND ELECTROLIERS.

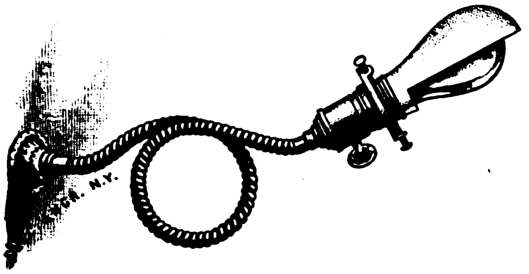


FIG 5.

It might, on first thought, be considered impossible to make a metallic tube which would be quite flexible and which could be made to convey gases and liquids under considerable pressure, as well as electric wires. This has, however, been successfully accomplished by Mr. J. R. Almond, of No. 83 Washington street, Brooklyn. The manner in which the tube is formed will be apparent from the accompanying engravings. When a tube is formed by coiling a wire around a mandrel (Fig. 1), the convolutions may be made to press upon each other with considerable force, and the joint formed at the point of contact of the individual convolutions will be tight in proportion to the amount of pressure exerted. If such a tube be bent, the joints will be broken all around the coils except at one point, and therefore, when bent, it is useless for conveying liquids or gases. But if, between the convolutions of the spring there is interposed a triangular shaped wire, as shown in Fig. 1, the convolutions of the triangular coil adjust themselves to the spaces between the round coils, as shown in Fig. 2. The triangular wire is pressed between the coils of the round wire, during the process of constructing the tube, with sufficient force to spread them apart, so that the contact surfaces are at all times under pressure. The triangular wire serves two purposes. One is to spread the coils apart, so that the pressure will be exerted on the contact surfaces; the other, to fill the irregularly shaped spaces between the coils of round wire, adjusting itself to the changing form of the spaces due to any given flexion. This pressure brings into play the element of friction to such an extent as partly to destroy the flexibility of the tube, which, when bent, will retain the form given to it. This was an unlooked for and unexpected quality. As the primary object was to obtain a flexible tube, trials were made with wire having a more obtuse angle, such as is shown by Fig. 3. This gave better results, as a more perfect joint was produced, with less tension of the inner coil, and the friction became correspondingly less, the result being a tight tube with sufficient flexibility. Fig. 4 shows the shape of the seats into which the round wires are forced by their tension.

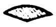


FIG. 3.

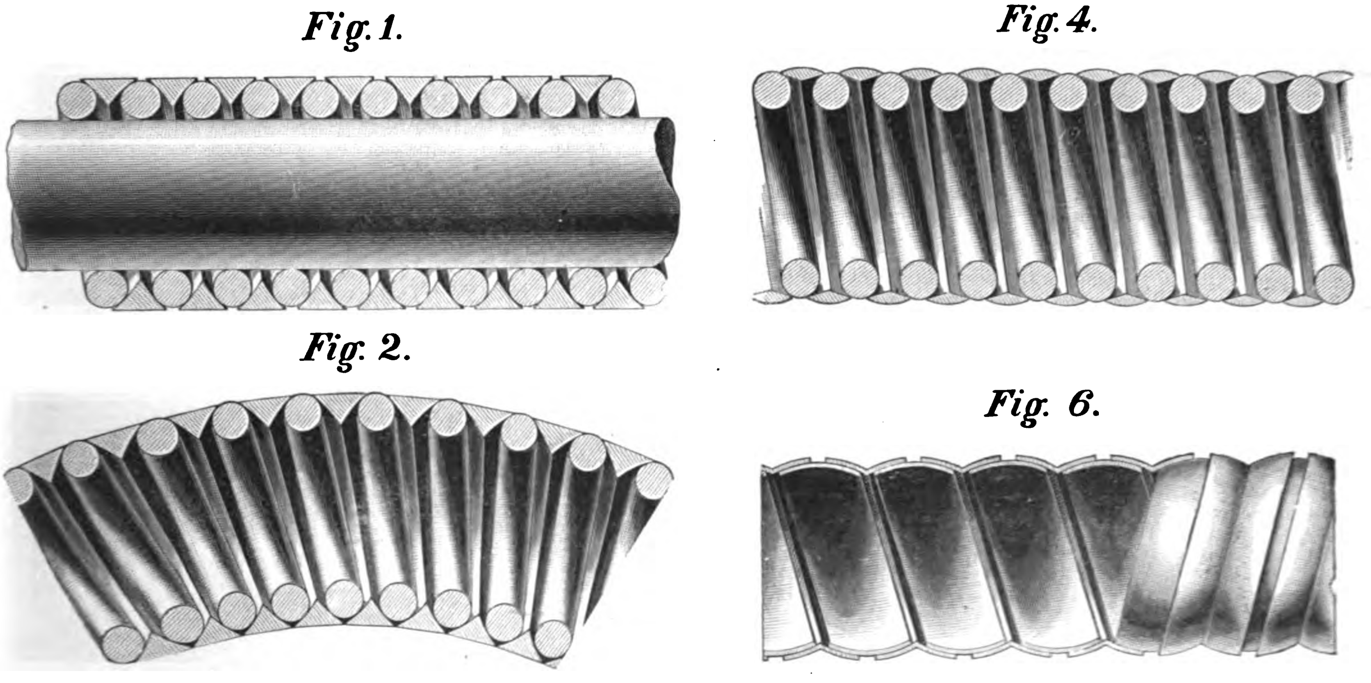


Fig. 1.

Fig. 2.

Fig. 4.

Fig. 6.

FIGS. 1, 2, 4 AND 6.—ALMOND'S FLEXIBLE METAL TUBING FOR BRACKETS AND ELECTROLIERS.

Our engraving, Fig. 5, shows the great adaptability of this ingenious flexible tube to bracket and chandelier work for electric lighting purposes, both for plain and combination fixtures, as the tube is both gas and water tight. The tube shown has been subjected to a steam pressure of 75 pounds per sq. inch without exhibiting leakage, and can be bent to a circle 2 inches in diameter, the tubing having a bore of $\frac{5}{16}$ inch.

For electric work alone, where no pressure is required, Mr. Almond has designed the tube shown in Fig. 6, which is made of sheet metal and can be made as large as 2 inches in diameter.

THE RIKER ELECTRIC MOTOR CO.

The Riker Electric Motor Co. factory is a very busy place at present. They have been making extensive alterations, adding to their machinery, and increasing their force of help preparatory to a large demand for their new types of multipolar and bipolar slow speeded motors. They are now prepared to fill orders on all sizes of the bipolar, which is made up to 4 h. p., and on their multipolar machinery to 25 h. p. In addition to their regular stationary machines, they have a most presentable and efficient design for direct acting machinery and are at present mounting a large number on ventilating fans of different makes from 24″ in diam. to 60″.

Mr. Riker is to give his attention soon, he says, to infringers of his patents, and it would be well for purchasers of dynamos and motors of other makes to investigate the matter beforehand. It is well know that Mr. Riker, young as he is, has been a pioneer in much of this work, and he believes that his patents and claims will hold.

SHULTZ BELTING CO.—The Shultz Belting Co. have 8 of their woven leather belts in use on the Lindell Electric Railway Co. in St. Louis, each 70 feet long and 24 inches wide.

NEW DEPARTURE OF THE BALL ENGINE CO.

There seems to be a prospect that the well-known Ball engine, many of which are doing such good service in the East, will shortly be manufactured by a new company organized for that purpose in the vicinity of New York. We understand that a number of New York gentlemen have made arrangements with Mr. F. H. Ball, of Erie, Pa., the inventor of the engine, and having bought his patents, Mr. Ball will sever his connection with the Ball Engine Co., of Erie; and shortly take up his residence in the East, where he already has many friends among our leading mechanical engineers.

It is expected that the new company will be incorporated with ample capital, and that new shops will be erected possessing all recent mechanical improvements. The Ball Engine Co., of Erie, will continue as at present to manufacture the engine under Mr. Ball's shop rights, and with Mr. James McBrier as president, whose large lumber and other interests in the West have made his name familiar to business men in that section. The relations between the Erie and New York companies will be very cordial and intimate, since the latter will be largely interested in the stock of the former.

Prominently associated with Mr. Ball will be Mr. Thos. C. Wood, who for many years has been connected with the engine interests both in Erie, Pa., and in New York.

The new enterprise is the result of the increase in demand for the Ball engine, Mr. Ball's system of governing having proved so successful, and the Ball engine so reliable, especially for the electric light and street railway interests, that it is safe to assume for the new company a large and profitable business from the start.

ELECTRIC RAILWAY WORK AT AMSTERDAM, N. Y.

On Saturday, Dec. 20th, the Amsterdam and Rockton Electric Railway opened to the public the Maine and Division street line, just equipped, which had up to that time been operated by horses. The trial trip was a great event in the history of Amsterdam and excited much enthusiasm among the citizens. The Market street branch, an entirely new line, was opened January 16th, and its successful operation, comprising as it does, some of the steepest grades ever met with in street railway practice, is considered another triumph for the electric motor. The up grade on this line is continuous for about 2,000 feet, and for a short distance is as high as 12%.

The equipment has been in the hands of Woodbridge & Turner, electrical engineers, who have made it a model in the way of construction. With the completion of the Rockton branch, the road will comprise about four miles of track, operating five cars.

The track is of 48 lb. Johnson girder and 40 lb. T rail. Edison-Sprague motors are used, with the new Eickemeyer winding, mounted on Brill trucks; and special track brakes are provided for use on the heavy grades. The line work is a sample of neat, strong and durable construction.

The power plant is located temporarily in the old electric light station, but in the spring as soon as the weather permits, a new building will be erected to accommodate both the electric light and railway plants, these two companies being now consolidated.

CENTRAL ELECTRIC CO., CHICAGO.

The Central Electric Co. will shortly present to the public a very handsome and complete catalogue of electrical supplies. The page will be 7¼ inches x 11 inches, printed on heavy enameled book paper. It will be a fine sample of printing and bindery work, as well as an electrical encyclopedia. Each article will be described by a trade word, which will greatly facilitate ordering supplies, and save considerable expense when orders are sent by telegraph. The book will appear inside of 30 days.

The Central Electric Co. will shortly place upon the market a direct reading voltmeter and ammeter. It is claimed that this new instrument is as good as any that has been produced. It will be elegantly finished, as well as thoroughly standardized, and will be sold at a price so low that everyone connected with electrical work can afford to buy one.

Since the Central Electric Co. divided up their offices and appointed heads to the different departments of the business, they find that they can profitably assign one man to railroad supplies, and propose to vigorously push that department of the business in future. They already control some very valuable electric railroad specialties which will be placed upon the market with the accustomed vigor of this company.

THE LECLANCHE BATTERY CO.

The factory and office of this company have been removed to Nos. 111 to 117 East 131st street, in this city, where, with greatly increased space and facilities for manufacturing, they will be able to fill orders without delay, for their well-known and universally used battery.

CHAS. A. SCHIEREN & CO.

Mr. G. H. Fisher, formerly the secretary of the American Leather Link Belt Co., has become manager for Chas. A. Schieren & Co., manufacturers of the celebrated patent perforated electric belting, at 226 North Third street, Philadelphia, Pa.

THE MAYER MOTOR.

The Zucker & Levett Chemical Co., of 40 Murray street, New York, the well known manufacturers of chemicals and machinery for electro-plating and electro-typing purposes, have made arrangements to build the motor designed by Mr. Max Mayer and described in our issue of January 7th. The machine, which will be known as the Hercules, will be built in all sizes and for all circuits.

THE BUNDY WORKMAN'S AUTOMATIC TIME RECORDER.

In factories, shops and stores where a large number of people are employed and where the minutes lost individually aggregate many hours, it is necessary to keep strict account of the time at which employés begin and leave their work. The employment of a special time-keeper for this purpose, not only entails considerable expense, but is open to the objection that it gives rise to frequent disputes as to the accuracy of the time-keeper's record.

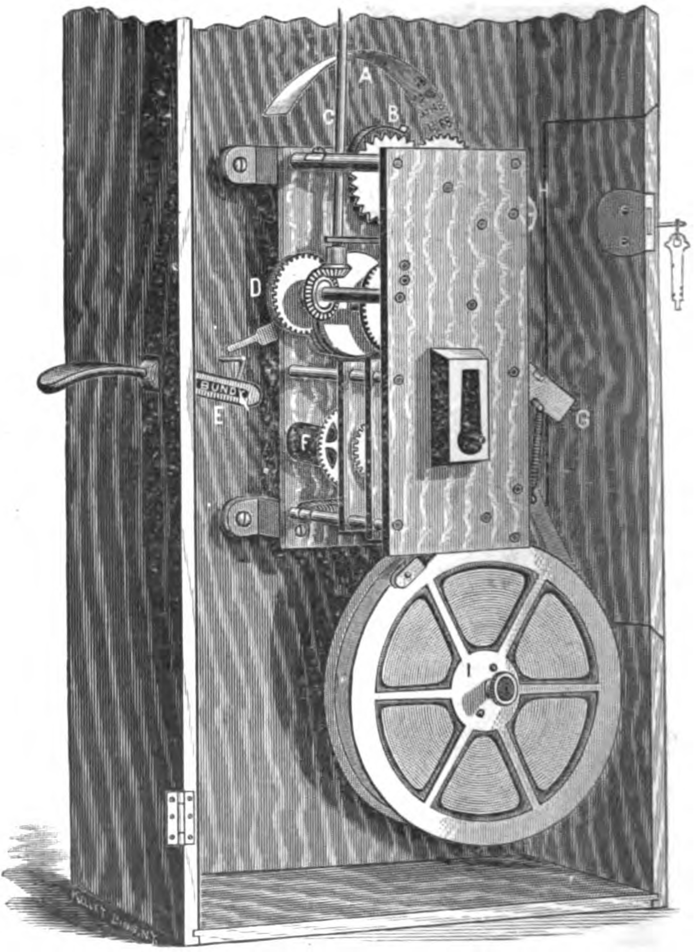


Fig. 1.—The Bundy Workman's Recorder.

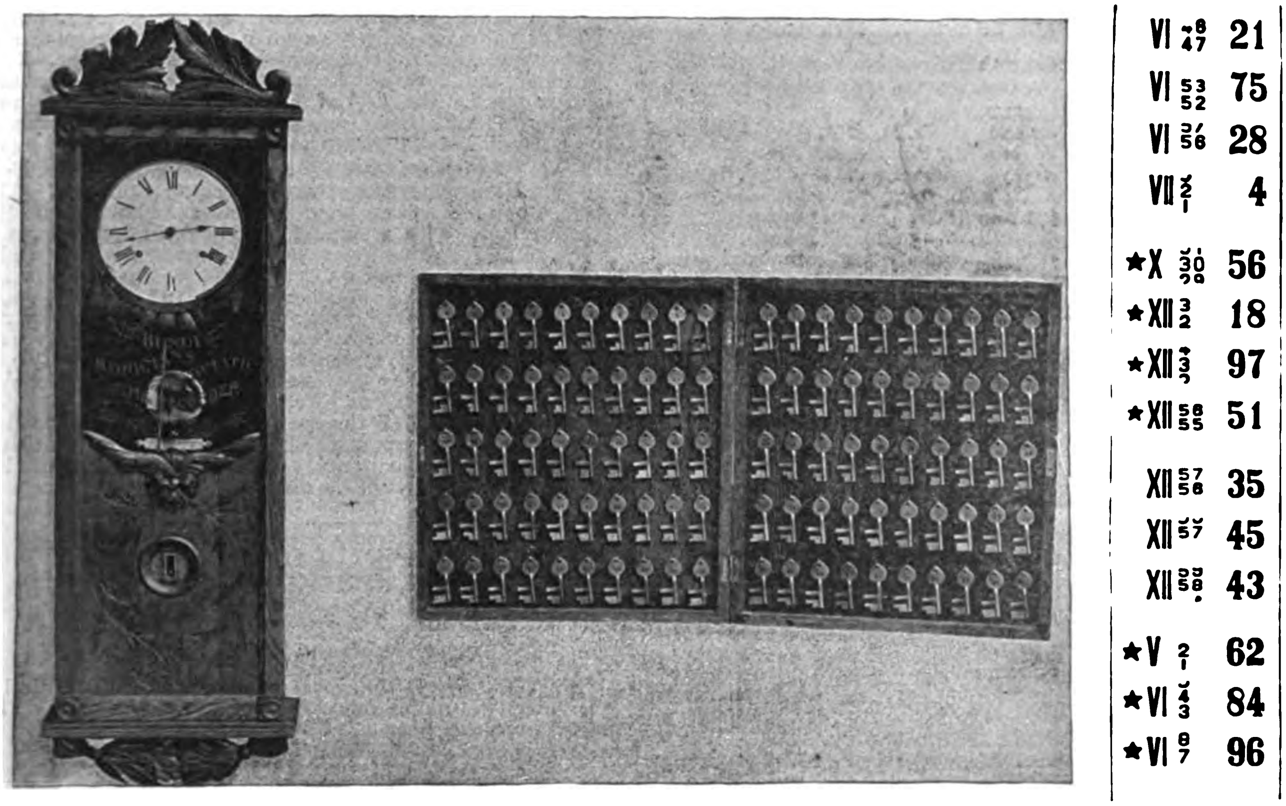
A system, therefore, which practically makes every man his own time-keeper will be admitted to be a valuable adjunct to every factory and workshop.

This has been completely provided for by the ingenious workman's automatic time recorder of the Bundy Manufacturing Co., of Binghamton, N. Y., an illustration of which is given in the engraving, Fig. 1.

Each workman is given a number, and when he goes to work he takes his key from the key board, inserts it in the keyhole of the recorder, turns it half way round, takes it out and passes in to his work. This action records upon the paper ribbon within the machine the number of his key and the exact time of day to the minute. If it is desired to register when going out, the workman holds down the lever on the outside of the recorder while registering, which prints a star in front of the record. Fig. 2 shows the working parts, the rod C connecting the minute wheel of the clock by a simple bevel gear to the minute type weeel. The hour wheel by means of a little pin is thrown ahead one number each revolution of the minute wheel; thus it will be readily seen that the time printed must correspond with the time shown by the clock.

The keys have two functions. One tongue trips the hammer, which is not released, however, until the other tongue, by means of step cams, geared to type wheels, has thrown the necessary number in front of the hammer, so that when the hammer falls it must print not only the time as shown by the clock, but the number of the key used. The paper, of course, is spaced with each blow of the hammer, and with every sixth blow of the hammer the ink ribbon moves ahead one notch, so the print is always fresh and clear. It is stated that 100 men can easily register inside of five minutes.

Fig. 3 illustrates a piece of the paper ribbon as it appears printed when removed from the recorder. From this slip it would appear that No. 21 registered at between 47 and 48 minutes past 6 o'clock; No. 75 at 6:53 o'clock; No. 28 at 6:56 o'clock, and No. 4 at 7:02 o'clock; No. 56 went out at 10:30 o'clock; No. 18 at between 2 and 3 minutes past 12 o'clock, and so on through each number as indicated. It will thus be seen that the time of each employé can be read off at a glance, and there is no chance for a mistake. The slips of paper can be removed daily, twice a day or weekly, and filed away, and the workman's time is practically in his own handwriting, but is entirely beyond his control. To prevent one man from registering for another, as each register is recorded a bell rings, so that a man registering twice could be easily detected by anyone in sight. The recorder also has a device by which the key after a partial turn is locked in and cannot be taken out until it registers, so that the excuse of an attempted register is out of the question. The apparatus is so simple that it is practically impossible to get out of order.



FIGS. 2 AND 3. BUNDY'S WORKMAN'S RECORDER.

THE CROWDUS CHEMICAL ELECTRIC CO., OF MEMPHIS, TENN.

This company has just been organized to manufacture a multipolar cell battery for electric lighting and power purposes not exceeding two horse power, and for all purposes where a powerful and constant battery is required. This cell has been designed by Mr. Walter A. Crowdus, and the solution employed contains no chromic acid, in consequence of which, no precipitates or crystals are formed. The elements employed are carbon and zinc, and the connections of both zinc and carbon are submerged in the body of the liquid, by which arrangement all corrosion is avoided. The battery having a surface of 12 inches, an output of 50 amperes is obtained and it is able to drive a fan at 1,600 revolutions per minute each working day without any attention, and at a cost of only ½ cent per hour. During this time the battery consumes one gallon of solution costing 15 cents a gallon. It is estimated that the cost of operating the battery, including everything, does not exceed 40 cents a week. The company expect to be ready shortly for business, and are so thoroughly convinced of the qualities of their cell that they will guarantee all their goods. For electric lighting they estimate that the cost will be less than two cents per hour for a 16 c. p. lamp.

HABIRSHAW WIRE IN THE WEST.

Among many testimonial letters in regard to Habirshaw wire, The Electrical Supply Co., of Chicago, lately received the following from The Rockford Electrical Manufacturing Co., Rockford, Ill:

Gentlemen:—In reply to your favor of the 7th inst.——say that we have been using Habirshaw wire under the most trying conditions for the past year, and have yet to hear the first complaint. We believe it to be fully equal, if not superior, to any wire on the market and shall continue to use it in preference to any other where the highest quality of insulation is required.

Yours very truly,
ROCKFORD ELECTRICAL MANF'G. CO.,
per GEO. A. MAYO, E. E.

MR. E. G. BERNARD.

Among the recent plants sold by E. G. Bernard, the well-known engineer and contractor of Hall Building, Troy, N. Y., are Gardner & Warren, knitting mill, Amsterdam, N. Y., 200 lights; Victor Knitting Mills, Cohoes, N. Y., 300 lights increase. This last plant makes Mr. Bernard's fifty-fourth knitting mill contract.

THE WIGHTMAN ELECTRIC MANUFACTURING CO.

The above company, of Scranton, Pa., has just issued a very neat and tasteful calendar for 1891. The engraving represents two big ocean "grey-hounds" racing, and on the bellying sail of the one in the lead is the name of the Wightman Co. We have submitted the calendar to our naval expert, who pronounces the drawing to be a fine piece of marine work to come from an inland town, and to be very creditable to the designer. The company are manufacturers of and dealers in electric machinery, and specially slow speed railway motors. L. R. Bacon is president of the company; Merle C. J. Wightman, vice president and electrician; H. Bergholtz, general manager; Horace E. Hand, secretary and treasurer.

MR. E. T. COPELAND.

Electrical and steam engineering circles have been very much interested in the announcement made recently in our columns to the effect that Mr. E. T. Copeland, so long associated with the New York Safety Steam Power Co. as its general agent and business manager, was about to make a new departure. During his twelve years of service in the above capacity, Mr. Copeland has seen, and assisted in promoting actively, the growth of the electric light and power industry; and at a time when the business was as much in need of steam engineering talent as of anything else, he bent all his energies with great success to the equipping of well-planned stations and isolated plants. He has now established himself as E. T. Copeland & Co., at 106 Liberty street and 111 Cedar street, where he will devote himself to steam engine and boiler work, &c., and in his new field of labor may count confidently on enhancing his reputation and increasing the number of his friends and customers. Mr. Copeland has already made arrangements for the manufacture and sale of desirable engines, which he will handle, and a little later we shall have fuller mention to make of his plans in their various details. As before, he will be prominent in the electric light and power field.

DENIAL OF SALE OF THE WENSTROM CO.

The following letter from the Wenstrom Consolidated Co., of Baltimore, dated Jan. 16, to their agents, tells its own story:

MESSRS. CHADBOURNE, HAZELTON & Co.,
General Agents Wenstrom Con's. D. & M. Co.,
416–420 Walnut St., Philadelphia, Pa.

Gentlemen:—Replying to your favor of the 15th inst., in which you state that rumors have come to you from various sources that the Wenstrom Co. has been bought out by other concerns, I beg to say that you may emphatically deny all such reports.

The Wenstrom Co., as you know, have just completed one of the finest electrical factories in the world, and being possessed of many valuable patents and having demonstrated the superiority of their generators and street car motors, are in a position to fill all orders promptly and believe that any combination which could be suggested, would be a hindrance rather than an assistance to them. You may assure your agents and customers that we are in an entirely independent condition, and are prepared to deliver goods promptly.

Truly yours,
THE WENSTROM CONSOLIDATED DYNAMO & MOTOR CO.
[Signed.] E. L. TUNIS, President.

ST. LOUIS TRADE NOTES.

THE ROSE ELECTRIC LIGHT SUPPLY CO., the well-known dealers in second hand electric light apparatus, are meeting with continued success in their special line of business. Among late sales may be mentioned:—50 arc light American machine and 40 lamps to the St. Louis Wire Mill Co.; 25 arc light Western Electric machine to Pawpaw, Mich.; 25 arc light Western Electric machine to the Tamarack Copper Mining Co. Dallas Bay, Mich.; two 35 arc light Ft. Wayne Jenney machines to the Greencastle Electric Light and Power Co., Greencastle, Ind.; 6 arc light Van Depoele machine to G. W. Farnsworth & Co., Fond DuLac, Wis.; 300 light U. S. incandescent machine to the Electrical Engineering and Supply Co., Elmira, N. Y.; 150 light incandescent machine to the Effingham, Ill., Electric Light Co.

THE SHULTZ BELTING CO. are crowded with orders for their famous rawhide and woven leather belting. They have just finished an order for eight 24 inch woven leather belts for the power station of the Lindell Railway. Their woven leather belting, which is a radical departure from the usual forms of link belting, in that wire rods are replaced by rawhide rods, is meeting with unqualified success wherever introduced.

THE ST. LOUIS ELECTRICAL SUPPLY CO., 403 North Eighth street, one of the oldest electrical supply houses in the city, report a most satisfactory increase in their business during the past year, with prospects for heavy trade during the coming year. W. L. Scott is president and treasurer.

THE EMERSON ELECTRIC MANUFACTURING CO., No. 513 Elm street, are bringing out a new ceiling block, the main features of which are the ease and convenience with which it can be attached to the ceiling, and with which the fuse wires can be renewed. It is made of extra quality porcelain in two parts, which lock together by a simple device which at the same time completes the connections between the lamp flexibles and the mains, and also tightens the terminal connections of the fuse wires.

THE WESTERN ELECTRICAL SUPPLY CO., 310 North Third street, who went into business only a year ago, report a very successful run during the year. They are special agents for the Western states for Grimshaw wires, the demand for which is steadily increasing. Mr. T. J. Wilson is president and manager and Mr. P. H. Reichardt, vice-president.

NEW ENGLAND TRADE NOTES.

THE HOLYOKE MACHINE COMPANY, of Worcester, Mass., are doing a large business in fitting up electric light and power stations with shafting and pulleys, and have deservedly earned a reputation for first-class work. Amongst their most recent sales are the following: The Toledo Consolidated Street Railway Company, Toledo, O.; David Robinson & Sons, Toledo, O.; Memphis Electric Light and Power Company, Memphis, Tenn. They have also just completed the installment of the shafting and pulleys for the Quincy Street Railway Company, Quincy, Mass.

A. W. WHITCOMB, of Worcester, is enjoying a run at present on his automatic dynamos and motors of from 10 to 150 lights and from ¾ to 20 h. p. Mr. Whitcomb has exceptionally good facilities for turning out first-class work, and that his goods are meeting with general approval is amply vouched for by the number of excellent testimonials which he has recently received.

THE SCHUYLER ELECTRIC COMPANY, of Middleton, Conn., have nearly completed a large addition to their factory, comprising a new brick building 206 feet long by 60 feet wide by 3 stories high. The Schuyler Company are extremely busy at present with dynamos and motors, and are also doing a large amount of work in switches and other electrical apparatus.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., are busy preparing an entirely new line of motors, the smaller sizes to be two pole, and the larger sizes of the four pole type. They will be totally unlike the old Mather pattern, and will run at a much slower speed. The first of these motors will be ready in about a month. The Mather Company are also manufacturing a very complete line of measuring instruments, which are attracting attention for their accurate properties and extra good finish.

THE UNION ELECTRIC MANUFACTURING COMPANY, of Bridgeport, Conn., has been organized under the laws of the State of Connecticut, with a capital of $50,000, in 2,000 shares of $25 each. The following five well-known gentlemen have each taken 400 shares: F. A. Gilbert, Boston; James English, New Haven; John C. English, New Haven; Horace T. Clark, Bridgeport, and John M. Orford, Bridgeport. The object of the company is to buy or sell electric machinery, appliances and supplies for electric light, heat, and power, and the factory and offices will be located in Bridgeport. Messrs. J. C. English, Clark and Orford have sold their stock in the Bryant Electric Company, of Bridgeport, and Mr. W. C. Bryant, of the same company, has bought it. The prospects of the new company are very bright, and with such a combination of men so favorably known among the electrical fraternity the success of the company is assured.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of January 17, 1891, from New York, Boston and Washington; Pittsburgh, January 16.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	79	Edison Gen. Elec. Co	88
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Centl. & So. Amer	*145	Consol'd Elec. Lt. Co	...
Mexican	*210	Edison Illn'g Co. N. Y	70
Com. Cable Co	104	U. S. Elec. Lt. Co	30
Postal Tel. Cable	39	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	42½	Ft. Wayne Co	11
" Pref'd	25½	Am. Bell	204
" Series C	..	Erie	49
" " D	[illegible]	New England	51
" Int. Co	....	Mexican	.70 cts
Thomson Welding Co	....	Trop. American	..
Thomson Eu. Welding	....	Edison Phon'gph Doll	1

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	140
Ches. & Pot. Telephone	*62	Eck. & Sold. Home Elec. Ry.	55
Amer. Graphophone	10	Georgetown & Tenallytown	51

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	5⅝

* Ex Dividend.

THE
Electrical Engineer.

VOL. XI. JANUARY 28, 1891. No. 143.

THE INVENTORS OF THE ELECTRIC MOTOR.—IV

WITH SPECIAL REFERENCE TO THE WORK OF THOMAS DAVENPORT.

BY

Franklin Leonard Pope

EARLY in the spring of 1838, Davenport discovered the principle of the core moving within the magnetic field of a solenoid, which afterwards came to be well known by the name of the "axial magnet." Entertaining the conviction that in this principle lay the germ of an important improvement in electro-magnetic engines, due to the possibility of greatly increasing the effective length of the stroke, he at once prepared and filed in the Patent Office at Washington, a caveat describing his discovery, and giving an outline of the manner in which he proposed to apply it for the movement of machinery. Although this discovery was no doubt original with Davenport, the phenomenon had been observed by Peter Barlow as early as 1822.[1] So far as record evidence goes, however, the caveat of Davenport is believed to be the earliest proposition to apply this principle in any manner for industrial purposes.

As this caveat has never been published, a copy of it is given below, procured by permission of the heirs of the inventor, from the secret archives of the Patent Office at Washington.

The Caveat of THOMAS DAVENPORT, of the City of New York.

The said Thomas Davenport, having invented a new machine of which a description is hereinafter contained, and desiring further time to mature the same, files this his caveat in the patent office of the United States, and prays protection of his right till he shall have matured the same.

The design, purpose, and distinguishing characteristics of his invention are as follows:

Said machine is designed to create or supply a power for any purpose to which animal, mechanical or other physical power can be, or is, applied to move bodies and machinery of every description. It is composed of an instrument denominated in science a helix, which is formed by winding insulated wire proper for the purpose around a hollow cylinder or other shaped tube of thin metal or other suitable substance incapable of being magnetized, in the usual manner and proper quantity in making helices. Galvanism being passed through such wire in proper quantity the helix is complete. The helix should be so formed that the internal hollow will be smooth, firm and uniform throughout, so as to permit a long, straight and uniformly thick piece or bolt of iron of the same shape and nearly exactly filling said hollow cylinder or tube to pass and repass longitudinally through it with as little friction or obstruction as possible. The end of a bolt or piece of iron fitting said tube or hollow cylinder, as before described, is then inserted a short distance into said hollow cylinder or tube, and the helix being galvanized the bolt will be drawn forcibly entirely into said tube and a motion be thus created. It is this machine, composed of the helix and bolt of iron (neither of which do I claim separately), thus producing motion, which I claim as my invention. I have so far improved it as to produce a reciprocating motion by which a crank may be turned in the following manner: I take two of the above machines, and the helices being placed perpendicular, I attach the two bolts at each extremity of a balance or walking beam. I then alternately galvanize each helix, and while one is galvanized, I take off or suspend the galvanism from the other. The consequence is, that the helix which is galvanized draws down its own bolt, and the other, not being galvanized, allows its bolt to ascend. As soon as the latter bolt has nearly reached the top of its helix I remove the galvanism from the former helix and galvanize the latter. The bolt of this is then drawn down and the other bolt ascends, and so on alternately. Intermediate the centre of the balance or walking beam and one of its extremities, at a suitable distance between, is attached a rod which descends to a crank, and as the balance beam moves up and down the crank is turned and turns a wheel band or other instrument to communicate power or produce motion. I put a balance wheel on the axis of the crank, and the axis of the crank forms a convenient means of letting on and suspending the galvanism as before described. In order to do this, separate pieces of silver, copper and other suitable metal are fastened to the axis so as to go about half way around it, forming a semi-circle flat and smooth. The conductors from the battery and the conductors to the helices are placed in contact with those pieces of metal but so as not to communicate galvanism to each other, unless through the medium of those pieces of metal. Then as the axis revolves when the revolution brings the conductors both in contact with their pieces of metal their helix is galvanized, and when, by such revolution the contact ceases, the galvanism of the same helix is suspended, and so of the other helix.

Dated New York, May 5th, 1838.

Attest:

E. PAINE. THOMAS DAVENPORT.

Respecting the work which was carried on during the year 1838, I have been able to obtain but little information. There are indications that matters in New York were practically at a standstill. It was a period of extreme financial depression, in which even well established interests experienced no little difficulty in meeting their liabilities and carrying on their business. In February, 1839, Davenport received a letter from John H. Smith, of Glasgow, a nephew of Junius Smith, who organized the corporation which built the celebrated steamship the *British Queen*. It appears that Smith, who had visited America in the preceding summer, had seen a model of Davenport's apparatus in operation at the Mechanics' Fair in Castle Garden, and in his letter he intimated his desire to undertake the introduction of the invention in Great Britain, on Davenport's behalf. Writing from Brandon, in reply to this and other letters from Smith, on August 15, 1839, Davenport says:

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[1] This effect was noticed by Barlow in the course of an experiment in magnetizing a steel needle which was placed within a helix wound upon a glass tube. His own account of it is as follows:

"In performing this experiment, I employed a glass tube about 5 inches in length and ¼ inch in diameter; and it was observed, when the needle was placed in it, so that one-half of it projected beyond the end, that the moment the plates reached the acid, the needle was drawn instantly to the middle of the tube, and while the contact was continued it was held suspended in the centre of the tube when the latter was held vertically; the suspending power of the spiral exceeding the power of gravity. (The connection of the spiral with the conducting wires is here supposed to be made before the plates are immersed in the acid.)

"This effect is very curious, because the needle here remains suspended in the open space, directly in the axis of the tube, and not attached to either side as in the usual cases of suspension by attraction." BARLOW: *Essay on Magnetic Attractions*, etc. [2d edition, 1823.] p. 262.

The writer is indebted to Charles L. Clarke for the loan of the exceedingly rare work from which the above extract was taken.

The following editoral note referring to the same phonomenon appears in Sturgeon's *Annals*, vol. ii., p. 80 (Jan. 1838): "In answer to our correspondent, who wants to know if it be possible to suspend a needle in the air by transmitting an electric current through a helix in which the needle or bar is lying, we must say, yes. The fact was first shown at the London Institution, Moorfields. The battery employed was contrived by Mr. Pepys, and consisted of a single pair of plates of copper and zinc, each about 50 feet long and 2 feet broad, formed into a spiral on a cylindrical nucleus of wood, and placed in a barrel or circular wooden trough which held about 50 gallons of acid solution. The experiment may be made, however, with a battery of one square foot of each metal, immersed in a strong solution of nitrous acid. The helix must be of narrow bore, of 6 or 8 layers of spirals, and held vertically. The gravitating propensity of the needle may be much reduced by holding a bar magnet at a small distance above the helix."

In Alfred Vail's *American Electro-Magnetic Telegraph*, p. 59, is an account of "An Interesting Experiment of Supporting a Large Bar of Iron within the Helix. Discovered by Mr. Vail, Jan. 1844," which, so far as the writer is aware, is the earliest *published* account of the suspension of a soft iron bar of any considerable weight. The account is in the following words:—"It has been shown many years since that a magnetic needle would be drawn into and suspended within a helix conveying a galvanic current, and that in the case of using large bar magnets, the coils of helices might be made to move over them as in De la Rive's rings; but in no instance I believe has it been recorded or observed, that a bar of iron weighing a pound or more could be drawn up into the helix and there sustained in the air, as it were, without support. If the helix be connected with from 6 to 12 pairs of Grove's battery, the bar may be drawn up into its centre and there sustained in a vertical position by the action of the helix, forming an exceedingly interesting and paradoxical experiment."

> I have experimented these 18 months past with my own limited means, having constructed machines on more than 30 entirely different plans; making great improvements in the power in proportion to the weight, &c. . . . . . I have no doubt but that the power is unlimited, which can and ultimately *will be* successfully applied to all purposes for which steam-power is now used. . . . . . . An attempt is making in New York by some individuals who have a machine now exhibiting in Gold street, to *monopolize*, as they say, the business of Electro-magnetic speculation. They have obtained a charter, and are offering for sale shares of stock; but their machine, although inferior in principle of application to any ever before exhibited to the public, is precisely on the plan of one constructed by myself in the winter of 1835, a part of which is now at this place [Brandon].

In a subsequent letter to Smith, dated in New York, December 13, 1839, Davenport mentioned that he was driving a rotary printing press with a machine weighing less than 100 pounds.

In January, 1840, Davenport commenced the publication of a journal entitled *The Electro-Magnet and Mechanics' Intelligencer*. This was a small folio sheet 12 by 16 inches, and as its title-page announces, was printed on a press propelled by electro-magnetism. As a matter of curiosity we give a fac-simile of the head of this somewhat unique and not particularly well-printed publication. Copies of the two first numbers issued have been preserved. It is not known how many, if any, subsequent numbers were issued. Among the editorial remarks in the second number I find the following, which are quoted as explanatory of the plan and scope of the undertaking:

> The first number of the *Electro-Magnet* was issued on Saturday, January 18, 1840, which was the first paper ever printed by the power of Electro-Magnetism or Galvanism. The project was proposed and set on foot for the express purpose of bringing before the public some tangible illustration whereby the power might be brought forward upon as cheap and prudent scale as possible. How far we have succeeded, time must show. . . . . . As the second number of our publication is before the public, we would respectfully call the attention of those who wish to advance the cause of philanthropy to come forward and assist us in our experiment. That we may be considered chimerical by many we doubt not; but when all things are fully proved we shall hope for a better fate than many of our predecessors.

On January 28, 1840, only three days later, in a letter to his brother, in Brandon, he feelingly portrays some of the miseries which beset the path of this, the pioneer effort in electrical journalism:

> I have been obliged to bear the whole load in starting the paper and have no writer to aid me yet. I have talked with some, and find that it will cost $10 per week for editorial articles (which accounts for no more original matter), yet I intend to have friends enough soon that will help without expense to me. . . . . The truth is, I am now in the worst pinch in regard to means for supporting my family that I ever have been, yet my prospects are the most flattering, and I think the most sure to net me something handsome as early as spring. You see I have no way to get a few dollars in a place, except by the prospect of getting subscribers, which I have not yet tried to do. I have only to take time and make my trade in a lump.

A few months later Davenport appears to have made a second essay in the way of a journalistic enterprise, of which, so far as is known, only a single number was issued. The new undertaking was somewhat more ambitious in character, being printed in quarto form upon a sheet 16 by 22 inches. This journal was entitled *The Magnet; Devoted to Arts, Science and Mechanism*, and was "edited by S. J. Burr, secretary, U. S. Society of Science and Mechanism," presumably at the munificent salary of $10 per week, which in fairness it must be stated, was every cent that the work was worth. As a matter of interest, we copy the advertisement which appeared at the top of the first column, together with the prospectus:

> LIGHTNING IN HARNESS.
>
> **The Printing Press Worked By**
>
> LIGHTNING!
>
> EXHIBITION.
>
> *The Greatest Discovery of the Age.*
>
> The attention of the scientific, mechanical, and curious is respectfully invited to the exhibition of LIGHTNING IN HARNESS, which is this day opened at No. 4 Little Green street. (Little Green street is between Broadway and Nassau street, and runs from Maiden Lane to Liberty street.)
>
> The exhibition of Davenport's electro-magnetic engine will continue open this day, from 9 A. M. to 10 P. M.
>
> The engine is of sufficient power to drive a printing press, and those who witness the exhibition will find it printing the DECLARATION OF INDEPENDENCE.
>
> The proprietor has been induced to exhibit his electro-magnetic engines especially upon this day, for what can be more appropriate than, upon the anniversary of our nation's birth, to print the Declaration of Independence and send it by lightning throughout the whole world.
>
> Admittance free.
>
> July 4, 1840.

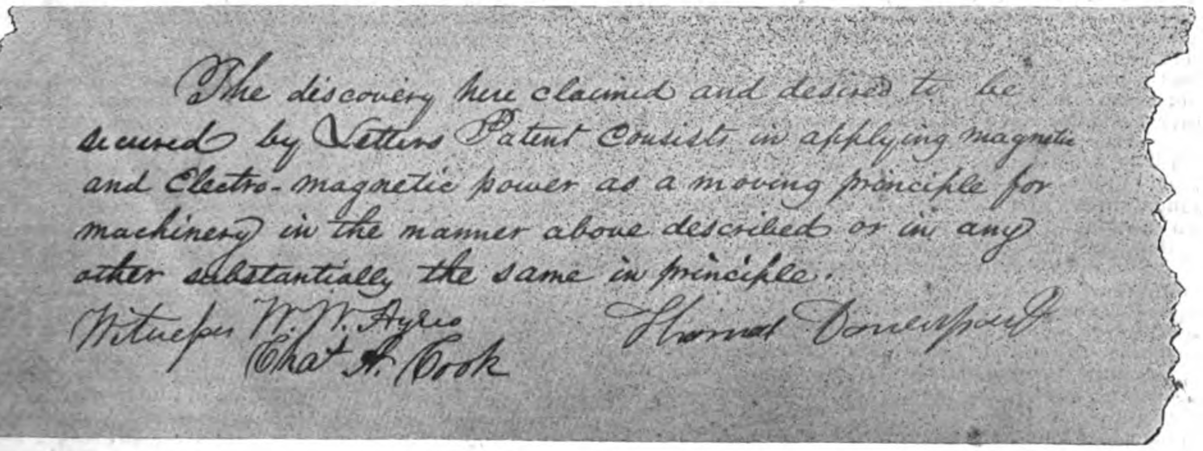
> PROSPECTUS OF THE MAGNET.
>
> We present our little work to the public with great confidence and for several excellent reasons: First. It is printed upon a new and improved conical rotary press. Secondly. This press is worked by our electro-magnetic engine. Thirdly. Both are wholly American. The first number of the paper is published on the anniversary of our national independence, and offered at a cheap rate to the patronage of the lovers of truth, and those who devote time and labor to mechanical and scientific pursuits.
>
> Though the investigation of electro-magnetism will form the principal feature of our journal, it is not intended to confine its columns to that interesting science; we shall fill our pages with such authentic matter as may come within our reach upon all scientific and mechanical subjects.
>
> With respect to electro-magnetism, it is the intention of the publisher to advance tangible proofs that this power has already triumphed in moving machinery. It is also his design to make known all the experiments made by him since December, 1833, which go to corroborate his views on this subject, with wood cuts, illustrating various models and machines, together with the laws of electro-magnetism, and the great advantage this wonderful power has over steam, in regard to safety, cheapness, and convenience. In the mean time, the experiments of others, more experienced in the science of electricity, galvanism, magnetism and electro-magnetism, will be noticed in order that the reader may get a general idea of the science, and the laws by which they are governed, and by which we are guided in controlling and working the powerful and mysterious agent. It is not our intention to make the subjects tedious, nor the articles too laborious for the ideas of readers in general.
>
> We shall treat upon the different branches of science, and the various inventions and improvements that shall be made known, as also those at present in operation, together with such miscellaneous and interesting matter as shall appear from time to time.
>
> Any objections or difficulties that may be advanced by different individuals, in regard to the application of electro-magnetism as a motive power, we shall be pleased to receive, and shall consider it a favor to communicate with them through the columns of the Magnet.
>
> Several scientific gentlemen of our city, Boston, and Philadelphia, have already engaged to become contributors to make our paper interesting and useful to all classes.
>
> THOMAS DAVENPORT.
>
> NEW YORK, July 4, 1840.

Two or three machines of different design were employed at different times, in driving the printing press. One of them was a helix machine, constructed upon the general plan proposed in the caveat of 1838 which has been given above.

The experiments of Davenport during the season had been so numerous and so costly that he again found himself at the end of his resources, and was reluctantly compelled to suspend operations. Receiving encouraging letters from Great Britain, he finally made arrangements to proceed to that country in order to personally negotiate the sale of his foreign patents, and it was only the lack of promised pecuniary assistance which failed to reach him on the very morning of his intended departure, that prevented him from being one of the unfortunate passengers of the ill-fated steamer President, which foundered at sea, carrying with her every soul on board.

Very little record remains of the labors of Davenport for some time after the occurrences which have just been narrated. It was, however, at some time during this period, that he experienced one of those cruel disappointments by which fortune sometimes seems to delight in making a foot-ball of the struggling inventor. The story of this misfortune is best given in Davenport's own words:

> A gentleman residing in Ohio, finally proposed to assist me to an amount which I considered would enable me to put the electric-motor power on such a footing that it should no longer prove problematical whether electro-magnetism could be used instead of steam. As I had for a long time been completely destitute of means for carrying on my business, and even for comfortably supporting myself and family, I now felt not only relieved as regarded my daily subsistence, but I was much elated at the idea of having sufficient funds to build a proper Electro-magnetic engine.
>
> This gentleman funished me with $8,000 in Ohio bank notes. Of these notes I had used only $10 when I was informed that the bank that had issued the notes had broken, and that my money was good for nothing. This proved to be the fact, I never received $10 in cash for the remaining $2,990. After struggling along for nine months more in trying to convince my friends that the object of which I had so long been in pursuit was still worthy of their attention, I reluctantly gave up all hope of further assistance, and in the fall of 1842 moved my family to Brandon, Vt., where I resumed work at my trade as a blacksmith, which was then my only resource to gain a livelihood.



The discovery here claimed and desired to be
secured by Letters Patent Consists in applying magnetic
and Electro-magnetic power as a moving principle for
machinery in the manner above described or in any
other substantially the same in principle.
Witnesses W. W. Ayres Thomas Davenport
Chas A. Cook

CLAIM OF DAVENPORT'S PATENT. NO. 132 OF FEBRUARY 25, 1837.
[*Fac-Simile from Original Specification in Archives of Patent Office.*]

Early in 1843, the inventor's nervous system, enfeebled by so many years of incessant toil and anxiety, gave way under the strain, and a protracted and dangerous illness ensued, which left him with a constitution permanently impaired. After residing two or three years in Brandon, he retired to a small farm in Salisbury, Vermont, where he passed the few remaining years of his life. He could not, however, wholly withdraw his mind from the fascinating science which had for so many years been a part of his very life, and in the retirement of his quiet home, he continued his studies and experiments in electro-magnetism.

In February, 1849, a memorial of Dr. Charles G. Page was presented in the United States Senate by Senator Benton, asking for the appointment of a committee to examine the merits of an invention for applying electro-magnetism to the purposes of navigation and locomotion, and a committee of seven was appointed for that purpose. In March an appropriation was granted, in pursuance of the recommendation of this committee:

> For testing the capacity and usefulness of the electro-magnetic power, as a mechanical agent for the purposes of navigation and locomotion, and the probable cost of using the same according to the invention of Professor Page, the sum of *twenty-thousand dollars*, to be expended under the direction of the Secretary of the Navy in making a practicable experiment of said invention according to the plans to be proposed and conducted by Professor Page.

From time to time accounts of the experiments of Dr. Page found their way into the journals of the day, and one of these notices, coming into the hands of Davenport, led him to send a communication to a local newspaper, which is not only valuable in itself, as a concise review of the author's own work, but because it was the occasion that led to an interesting correspondence between Davenport and Page, the essential parts of which are printed herewith, and which form a contribution of no inconsiderable importance to the history of the development of electro-magnetism as a motive power:

> [*From the Brandon Post, Sept. 26, 1850.*]
>
> ELECTRO-MAGNETISM TRIUMPHANT OVER STEAM.
>
> Mr. Welch:—Will you allow me a small space in the *Post* for the purpose of making a few remarks respecting Professor Page's successful experiment in applying Electro-Magnetism to propelling machinery, as described in the following article which recently appeared in the *National Intelligencer:*
>
> > **Electro-Magnetism as a Motive Power.**
> >
> > Professor Page, in the Lectures which he is now delivering before the Smithsonian Institution, states that there is no longer any doubt of the application of this power as a substitute for steam. He exhibited the most imposing experiments ever witnessed in this branch of the science. An immense bar of iron, weighing 160 pounds, was made to spring up by magnetic action, and to move rapidly up and down, dancing like a feather in the air, without any visible support. The force operating upon this he stated to average *three hundred pounds* through ten inches of its motion. He said he could raise this one hundred feet as readily as through ten inches, and he expected no difficulty in doing the same with a bar weighing one ton or one hundred tons. He could make a pile driver or a forge hammer, with great simplicity, and could make an engine with a stroke of six, twelve, twenty, or any number of feet.
> >
> > It looked very unlike a magnetic machine. It was a reciprocating engine of two feet stroke, and the whole engine and battery weighed about one ton. When the power was thrown on by a motion of a lever, the engine started off magnificently, making one hundred and fourteen strokes per minute; though when it drove a circular saw ten inches in diamater, sawing up boards an inch and a quarter thick into laths, the engine made but eighty strokes per minute. There was a great anxiety to obtain specimens of the laths sawed in this way to preserve as trophies of this great mechanical triumph. The force operating upon the magnetic cylinder throughout the whole motion of two feet, was stated to be 600 pounds when the engine was moving very slowly, but he had not been able to ascertain what the force was when the engine was running at a working speed, though it was considerably less. The most important and interesting point, however, is the expense of the power. Prof. Page stated that he had reduced the cost so far that it was less than steam under many and most conditions, though not so low as the cheapest steam engines. With all the imperfections of the engine, the consumption of three pounds of zinc per day would produce one horse power. The larger his engines (contrary to what has been known before) the greater the economy. Prof. Page was himself surprised at the result. There were yet practical difficulties to overcome; the battery had yet to be improved; and it remained yet to try the experiment on a grander scale, to make a power of *one hundred horse* or more.
>
> As I am confident that the results of the experiments of this enterprising and scientific gentleman will open the eyes of the people and the purses of capitalists, sufficiently to soon place on our lakes, rivers and railroads, a safer and more convenient power than steam, I hope I may not regret so much in future as I have for ten years past, that the paralyzing hand of *poverty* has for-

bidden any attempt on the part of myself to prove to the world, what as early as 1833, I believed could be done within the space of five years. At that time galvanism appeared to me to have the same relation to the power of an electro-magnet that water does to the power of a steam engine, and I had no doubt but that I could convince the whole sensible world of the fact, by applying the power of a small electro-magnet to moving the lightest machinery. But in this I was disappointed. I found the power more controllable than the minds of men, and compliments more plenty than money.

Having devoted the most part of seventeen years of my life in laboring to apply electro-magnetism to useful purposes (and without receiving any remuneration), it may not be improper for me to state to the public the power and size of some of the electro-magnetic engines which I have invented and applied to the moving of machinery, that they may be compared with the engine lately constructed by Prof. Page. Early in 1838 I ascertained that a bolt of iron could be drawn with great force into a helix whenever the battery current was suffered to pass through the coil. I immediately constructed a small engine on this principle, which, when in motion, very much resembled a little steam engine with two perpendicular cylinders. During the same season I filed a caveat for this improvement in the United States Patent Office, and sent several models to Europe. A patent for this invention was obtained in England and the Provinces, and money paid into several other European Patent Offices where no letters patent have ever been obtained.

In 1839 I experimented on a much larger scale with the magnetic cylinder or helix, and constructed a helix two feet in length with an aperture through the centre two inches in diameter. A bolt of iron 2 feet long and 2¼ inches in diameter, weighing about 28 pounds, was forced into the helix when the current of galvanism passed through the wire, with a power equal to 6 pounds to the square inch of its diameter. This test was made with the helix and bolt placed in horizontal position, so that the weight of the iron should not be reckoned.

When the helix was in a perpendicular position and raised one foot from a platform, with the lower end of the bolt resting upon the platform, and the upper end entering one foot into the helix, the battery current would raise this bar of iron with such force that it would often pass entirely through the coil, 2 feet in length, and fall upon the platform.

In January, 1840, I had completed an engine with two magnetic cylinders weighing 50 pounds each. The engine made a 12-inch stroke and weighed about 200 pounds. The battery was made of lead and zinc plates 2 feet long and 5 inches wide, weighing in its most improved state 100 pounds. In the same month I commenced publishing a newspaper, which was printed on a press propelled by this engine. When the press worked off but 10 papers per minute, the engine made 120 strokes in the same time. Many who witnessed the working of this machine, estimated it to be a two horse power, but from my own tests, I could not make it exceed the power of one horse. The cost of zinc and acid in working did not exceed 25 cents per day. In the course of my experiments, up to the time of printing by this power, I had constructed in all more than 100 engines of various dimensions, and all different in point of construction, for the purpose of ascertaining the best proportions and mechanical arrangements for the increase of power. My experiments with helices, using long and short, large and small, hollow and solid bars of iron, were very numerous. My press was first moved by a horizontal helix engine, next by a rotary, and lastly by a perpendicular double helix engine. Now, as Prof. Page's experiment with 160 pounds of iron "dancing like a feather in the air" seems to me to be precisely like the experiment I made in 1839, when the 28 pounds of iron jumped through a helix two feet in length, by magnetic action, and as the Professor's engine is constructed on the same plan and principle as my own above described, I presume the scientific gentleman lays no claim to having presented any *new route* in his application of the power, or to have made any important improvement whatever in my invention. If Prof. Page, by the completion of his engine, has finally come to the point at which I arrived ten years ago in testing electro-magnetism as a prime-mover in the arts, and has expended as much money in the series of experiments which he of course would be obliged to make, I think I could have saved him the needless expenditure of several thousand dollars, by giving him the results of some of my experiments in 1838-9-40, which I should have been happy to do, if I had been consulted in due time.

THOMAS DAVENPORT.

SALISBURY, VT., Sept. 12, 1850.

The publication of this communication drew forth the following letter from Professor Page:

[*Letter of Charles G. Page to Thomas Davenport.*]

WASHINGTON, D. C., Oct. 2, 1850.

Dear Sir:—I have received this day your communication in the *Brandon Post*. I have been aware from the beginning of your experiments with the helix, and although we were operating entirely independent of each other, it will no doubt be gratifying to you to know of a promise of success in the common cause. I believe there is nothing in my improvements that conflict in any way with your inventions, but should it ever prove to be the case, I think we could make an amicable arrangement. I commenced my experiments on the helix primarily in 1830, and made several miniature models, and published accounts of several of them in the early part of 1837. In 1838, in the winter, I think, while I was in Davis' shop in Boston, a gentleman from New York called and said that you thought you could get power in that way, but that you had not yet arranged any machine. My experiments and little models had been successfully tried long before that, and I have always believed and am satisfied that I was the first that ever attempted to get power in that way.

In 1843 I made a great improvement on this principle, and many more since, without which I am satisfied nothing could be done to render the power available.

I have always looked with pleasure upon your zeal and ingenuity in this matter and when speaking in public have always alluded to you in terms of commendation, and although your article was no doubt written with feeling, yet I hope you will not repeat it until we can fully understand each other.

Respectfully, your obedient Servant,

CHA'S. G. PAGE.

THO'S. DAVENPORT, Esq.

[*From the Brandon Post, October* 31, 1850.]

WASHINGTON, D. C., Oct. 24, 1850.

Mr. Editor:—I notice in your paper a communication from Mr. Davenport, in which he gives an interesting historical account of his experiments in electro-magnetism, and concludes that he was in advance of myself in respect to the peculiar plan of operation which he describes. According to his own statements he *was* in advance of me in respect to the scale of magnitude of his experiments, and from the size of battery which he employed that would have necessarily followed. But the attempt to apply this peculiar principle of action to an engine for mechanical purposes was made and published, so far as I can learn, first by myself, and long before Mr. Davenport states that he was first aware of the fact that a bar of iron would be drawn into a helix. This fact has been long known to the world, having been first published by Mr. Barlow in 1823, and I apprehend that the reason why it has been so little thought of as a source of mechanical action, is that the force thus exerted was so very feeble compared with the attraction of the electro-magnet. As to raising a bar, I can of course claim no originality, and the raising of a bar of 600 pounds, which I now do readily, presents a difference only in degree from the experiment of Mr. Barlow in 1823 in raising a small bar, perhaps of only one ounce. But the peculiar improvements by which I raise so great a weight with so *small an expenditure* of galvanic power are novel and original with myself. Mr. Davenport is entitled to great credit for his ingenuity and zeal in the pursuit of electro-magnetism, and I have always viewed with much interest his early perseverance in this matter. But it is due to himself, the community and myself, that I should make this statement, and to add that I do not feel indebted to any one for the peculiar views which I have long entertained in regard to the plan of operation based upon the known fact above mentioned.

CHAS. G. PAGE.

In view of the historical interest attaching to the inquiry, the author has made every effort to verify the statement made by Professor Page in the two preceding letters in respect to his publication in 1837, of accounts of experiments with the helix and core, but without success. From other publications made by Professor Page, it seems impossible to avoid the conclusion that the dates given by him must have been the result of some misapprehension. In an article published in *American Journal of Science* in 1845, vol. xlix, p. 131, he says:

> This new species of electro-motion, which by way of distinction I denominate the axial reciprocating engine, was *unsuccessfully attempted in the year* 1838, and notice made of it *in this* journal (vol. xxxv for 1839, pp. 261 and 262) together with *some other experiments upon the interior of helices.* My failure at that time was for want of suitable batteries, etc. . . . . . .
> To sustain a small needle within the helix is a trite experiment, but by the arrangements which I have adopted, a bar of iron or steel (which becomes instantly and powerfully magnetized) is

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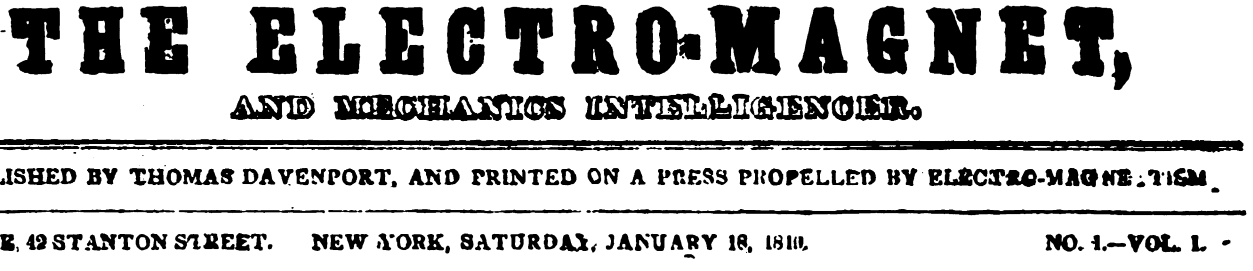
[2] The improvement here referred to by Professor Page, is probably that embodied in the engine which he exhibited in New York in the fall of 1851, and which is described with illustrations in the *Scientific American* of November 15, of that year (vol. vii., pp. 65, 67). This machine was fitted with a range of hollow helices formed of square wire. A sliding commutator was so arranged as to pass the current through three successive coils of the series at the same time, current being cut off from each rear coil in succession, and thrown on the coil in front of the core in the direction in which the latter is moving. Thus a stroke of any length in either direction could be given to the moving core. The battery used is stated to have been 40 pairs of 10 inch Grove's. This form of motor had been used in Professor Page's well-known experiment in propelling an electro-magnetic locomotive on the Baltimore & Ohio Railroad in April of the same year.

sustained entirely free from any visible support, and this too by the action of only six small Grove's batteries. This is almost a realization of the fable of Mahomet's coffin, or the statue of Theamicles. When the helix is connected with six pairs Grove's in good order, it will draw up within its centre a bar of iron or steel weighing two or three pounds and sustain it with its upper end projected above the helix

He then goes on to give a description of his well known axial reciprocating engine, for which he took a patent January 31, 1854, and which is described in many works on electricity and magnetism.[3]

Referring to the notice in vol. xxxv of *American Journal of Science* of which Page speaks in the above extract, I find that it describes an apparatus consisting of a pair of helices, with U-shaped cores thrust into them at each end, so that the four poles will meet in the centre of the helix. It is distinctly stated that this apparatus was contrived Jan. 11, 1838, but it is not properly an axial magnet, nor is any mode of application to the moving of machinery described. The inference seems unavoidable that Professor Page must have been in error as to his dates, and that Thomas Davenport is really entitled to priority in the application of axial magnetism to the movement of machinery, as set forth in his caveat of May 5, 1838, and as reduced to practice by him in 1838-39-40.



THE ELECTRO-MAGNET,

AND MECHANICS INTELLIGENCER.

PUBLISHED BY THOMAS DAVENPORT, AND PRINTED ON A PRESS PROPELLED BY ELECTRO-MAGNETISM

OFFICE, 42 STANTON STREET. NEW YORK, SATURDAY, JANUARY 18, 1840. NO. 1.—VOL. I.

FAC-SIMILE, FULL SIZE, OF THE HEADING OF DAVENPORT'S ELECTRICAL JOURNAL, ISSUED IN 1840.

[*Letter of Thomas Davenport to Charles G. Page.*]

SALISBURY, Oct.——, 1850.

Dear Sir:—Yours of the 2d inst. was duly rec'd. When I wrote the article which you noticed in the *Brandon Post*, I had no knowledge of the fact that Congress had appropriated any moneys for testing the availibility of electro-magnetic power. Since then, have received your report to the Secretary of the Navy on the subject of electro-magnetism as a moving power. I am truly gratified to learn that your experiments have resulted so favorably. I believe, however, that if I could have had in 1840, one half the amount of money that you have expended, I should have produced more power and fully as economically. I question whether, in proportion to weight, your machine actually exceeds in power the helix machine with which I printed a newspaper in 1840. But, the improved state of the galvanic apparatus would probably render your power a cheaper one. I perceive that you have made a great many experiments which were precisely like those I had tried, excepting that yours were on a larger scale. The impossibility of my obtaining funds to build larger caused me much regret. In completing my engine for printing, I had used up all the means I possessed, and all that I could get, for I had tired my friends with my solicitations for funds. After trying more than a year without success, I gave up all hopes of enlisting individuals any farther in the enterprise, and I then thought of applying to Congress for an appropriation for the purpose of testing the power on a larger scale. I asked the opinion of many intelligent and influential individuals in regard to my plans, but they invariably gave me unfavorable answers. In 1845-6 I wrote to some gentlemen and members of Congress on the probability of my getting an appropriation from the Government, but their answers were generally discouraging. But I will not tire you at this time with an enumeration of my misfortunes, for it pains me much to call to memory the many distressing circumstances in which I have been placed in consequence of my zeal in the cause. You mention that you believe that you are the first that ever attempted to get power with the helix, and that you had successfully tried a model previous to 1838; also that some of your experiments in the helix were published prior to that date. I find in Davis's "Descriptive Catalogue of Apparatus and Experiments," published in Boston in 1838, the following apparatus described: "Page's revolving helix," "Page's revolving helical ring." These experiments seem to be on the same principle as the "floating helix" and "De la Rive's ring."[4] In your improvements in the "floating helix," it appears that you had no idea of accumulating *power* in that way, for in your letter to me dated Boston, April 28th, 1838,[5] you have said nothing about any experiments with the helix, although you mention a variety of other experiments which you have made in producing rotary motions, without changing poles, and which you considered was an improvement on my system of changing the polarity of the magnet. You also stated in the same sheet, that you could show good reasons why the power would not admit of "indefinite increase," but must be confined to the power of that of one or two men. *Since I first saw the power of an electro-magnet exhibited, any idea that the power could not be indefinitely increased, seemed to affect me with a peculiar disagreeableness.* I write you thus plain, because I have had strong feelings on the subject, and retain them yet. I believe that my zeal and attachment to, and inventions in, electro-magnetism have been of great value to science and the arts, to government and to the whole world, and this I shall endeavor to show in a publication which I hope to have prepared in a few weeks, in which I intend to fully show my position in the matter.

You mention in your letter of the 2nd inst. that if your improvements in any way conflict with my inventions, there could no doubt be an amicable arrangement made between us. It strikes me that if Government has taken the business in hand to perfect the application of this power to moving machinery, that Congress would be the proper body for me to look to for compensation for what I have done in the premises. I should be happy, however, to receive suggestions from you with regard to the best course for me to pursue. In the meantime, I hope that Congress will make still further appropriations, that you may continue on in the noble cause.

For the last four years I have been experimenting in electro-magnetism on a plan for applying the power to new purposes; and have succeeded to my full satisfaction. This invention I consider of very great importance to the public, and I hope to be able in a few months to present you with a model for examination.

Respectfully your friend and fellow-laborer,
THOMAS DAVENPORT.

[*Charles G. Page to Thomas Davenport.*]

WASHINGTON, D. C., October 22, 1850.

Dear Sir: I have this day received your kind letter and although I differ with you in opinion on its most important points, still I believe you to be as sincere as you are zealous. I do not remember the letter of 1838 you refer to, but it has generally been my practice in writing to others upon the subject, to withhold such information as would give them an advantage over myself by giving them the benefit of my own inventions. However in 1838 and after, and in 1836-7, I was fully of the belief that an economical power could not be obtained, unless the difficulties of the time required to charge and discharge magnets and the influence of secondary currents could be overcome. These difficulties always increase with any increase in the size of the engines. I threw out all these objections in *Silliman's Journal* at that time, but I hoped and believed there would be a remedy; I was constantly searching after it, and at last I found it. It was only when I found it, that I thought the way was clear. You must estimate the power of your engine much too high. Your printing press was a very small one, and it would not have required, I think, $\frac{1}{10}$ horse-power to drive it at the rate you mention. I send you a pamphlet containing an account of the performance of my engine which was made about five years since, and which after I got it into the best working order I showed to Congress, working a planing machine (small one) and afterwards carried to Tower's printing office to test it. This engine had by accurate measurement, ¼ of a horse-power and yet you see how large a press it worked at the rate of twelve hundred impressions per hour. There are some other points in your published article which do not seem to me to be correct, as to estimates, etc. But there is no reason why I should raise a discussion now about them. You will notice in the pamphlet that I had given you credit for your labors (see page 6). There seems to be no hope from Congress now. They have taken the ground that it is a matter of individual enterprise, and on that ground they refuse to appropriate further for my experiments. I applied for forty thousand dollars to build a large ship with an engine of one-hundred horse-power, which they refused without a count.

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[3] See Davis's *Manual of Magnetism* [12th edition] p. 182; U. S. Letters Patent, No. 10,480; Martin and Wetzler, *The Electric Motor*, etc., p. 79.

[4] De la Rive's ring is a small helix of thin wire in the form of a vertical annulus which is mounted on a float, having a small plate of copper attached to one end and a corresponding plate of zinc to the other end, which hang below the float. The whole arrangement is then placed upon the surface of a vessel of acidulated water, which causes a current to pass through the ring. If the pole of a bar magnet is presented to the ring, the latter will move towards the centre of the magnet, passing over the bar. It is in fact an inversion of the solenoid and core, and involves precisely the same principle. (See *Davis' Manual of Magnetism* [12 Ed.], p. 115.)

[5] See *ante*, p. 71.

The great feature of my engine is the manner in which I overcome the difficulties I spoke of, and you will I am sure be gratified when you come to know the plan. It has never been made known in public yet, but by next spring my work will be published containing a full description. I shall be always glad to hear from you and render you any aid in my power. Meantime believe me to be,

Your friend and well wisher,

THOMAS DAVENPORT, Esq. CHARLES G. PAGE.

P. S.—I have kept a good account of electro-magnetic engines and I do not think that a horse-power was ever attained before my engine. Jacobi's great engine was about ⅛ horse-power, and so far as I can learn, was the most powerful ever made.

About the year 1850, Davenport became interested in the development of an idea which he had conceived, of producing music by electro-magnetism. The following notice of this invention appeared in a journal of the time:

[*From the Scientific American, April* 3, 1851.]

The Electric Piano.

Mr. Davenport, of Salisbury, Vt., we learn claims to have made an improvement in pianos, causing the musical chord by means of electric magnets to continue an equable and free vibration for any length of time. The perpetual and hitherto incurable defect of the piano-forte is the impulsive and evanescent nature of its tone, and though great improvements have been made upon it, and various devices have been elaborated to prolong its notes in some degree, yet the want of a sustained vibration is still an inherent defect in that beautiful instrument.

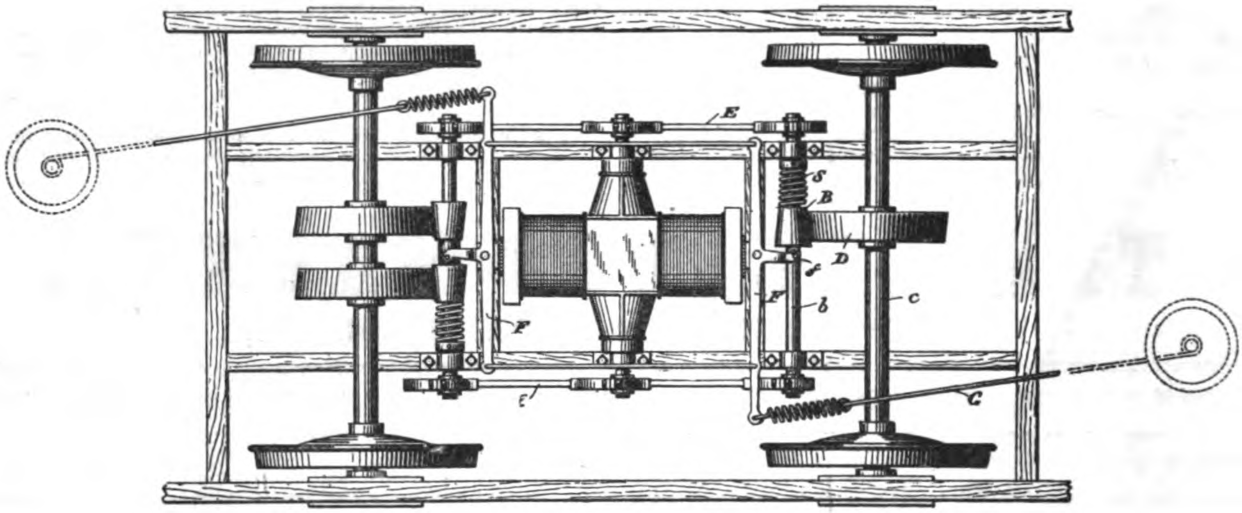
Davenport's work in this direction, which was attended with very satisfactory and successful results, was brought to an untimely end by his illness and death, which took place in the summer of 1851. It is my purpose to enter more at length into the history of his labors in this direction in a subsequent article.

BERLIN, N. H.—The Westinghouse Company is now installing a central station plant at Berlin, N. H., with the Westinghouse alternating current apparatus. The plant will commence operations with 750 sixteen candle power lights capacity.

McCARTHY'S ELECTRIC CAR GEAR.

AMONG the new devices designed to transmit the power developed by the motor to the car axle of an electric car we note that recently patented by Mr. L. A. McCarthy, of Brooklyn, N. Y. In this arrangement the inventor has sought to effect a simple arrangement by which the motor may be kept in constant operation, if desired, and thrown in and out of gear with the axle with the least possible jar, and thus to obtain efficiency with flexibility of connection. As shown in the accompanying engraving, the motion of the armature is transmitted to an intermediate shaft *b* by means of driving rods. Mounted upon this shaft is a movable cone pulley B placed directly opposite a corresponding friction pulley D, mounted on the car axle.

The pulley B is normally held out of contact with the pulley D by the spring S, and under such condition the motor runs free. When it is desired to start the car, the driver, by turning a lever on the platform, draws the rod G taut, which, acting upon the bell crank lever F, moves its short arm *f*, and presses the cone pulley B firmly against the pulley D. In this manner the motion is transmitted without shock and is under complete control of the driver.



McCARTHY'S ELECTRIC CAR GEAR.

THE PRACTICAL VALUE OF THE PHONOGRAPH.

The greatest feat of reporting that has ever been performed by the official reporters of Congress was that of preparing the Senate report for the *Record* Wednesday night, Jan. 14. The chief reporter is sick, and but two men were available to do the work. The Senate was in session for fourteen hours, all of which time was spent in an active discussion of the silver bill. It was after 12 o'clock at night when they adjourned, and during the session they had talked over 120,000 words. Two stenographers took the report, and, by dictating their notes into phonographs for typewriters to transcribe, they had all the copy ready for the printers by 8 o'clock in the morning, and the *Record* was on the desks of the Senators when Congress convened.

LAWS AGAINST THE EMPLOYMENT OF JUVENILE OPERATORS.

At its last session, the Georgia Legislature passed a law providing that in the future all railway telegraph operators must be not less than eighteen years of age before they can accept such positions, and, furthermore, they must pass an examination as to capability before the chief train despatcher of the road upon which employment is sought. Tennessee operators will push a similar measure before the Legislature of that State. They claim that the passage of these bills means the disappearance of the boy operator and a corresponding decrease in the number of accidents resulting from the employing of inefficient, immature and inexperienced railroad telegraphers. It would be well, perhaps, if every State should adopt such a law.

MR. W. H. McCULLOCH, manager for the Southern Telephone Co., at Greenville, Miss., has been promoted to the position of supervising auditor, with headquarters at Vicksburg. Mr. D. Thomas, of Memphis, succeeds him.

THE BUFFALO ELECTRIC RAILWAY.—THE LATEST DEVELOPED TYPE OF ELECTRIC STREET RAILWAY PRACTICE.

BY

C. J. Field

THE subject of electric street railway practice is of much interest at the present time, owing to the very rapid strides which are being made in this department. Owing to the rapid introduction of electric cars there has not been time to develop this line of the work as it went along to the degree of perfection now attained in electric lighting. As a result we have, in many parts of the country, engineering monstrosities in the way of station construction and line equipment. There has been no extended experience in the larger fields of railway work; therefore we have got to base and modify our experience on the more moderate sized plants, which, together with our knowledge in larger development of central station work in the light lines, enables us, with careful and at the same time progressive engineering to avoid some of the more marked errors which are apt to be made. Without entering further into the discussion of past experience we will take up a particular modern case in general detail, and try to show in what manner each part has been developed.

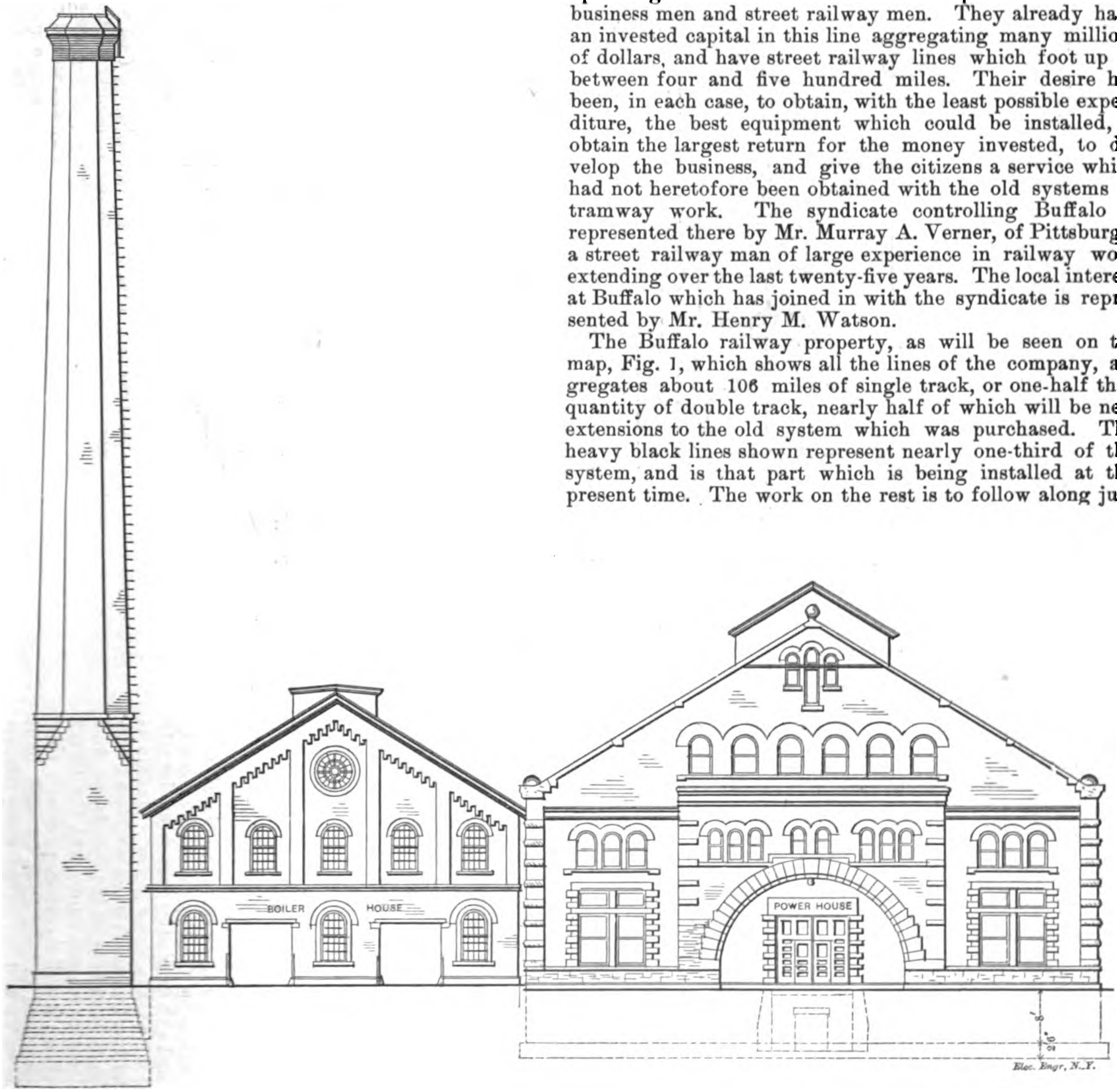


FIG. 2.—BUFFALO STREET RAILWAY POWER PLANT.—FRONT ELEVATION.
Designed and Constructed by The Field Engineering Co., of New York.

We have taken as an example the plant of the Buffalo Railway Company, which is the consolidation of all the street railway companies in Buffalo, N. Y., and is owned and controlled by one of the largest syndicates which is operating in this field and which is composed of bankers, business men and street railway men. They already have an invested capital in this line aggregating many millions of dollars, and have street railway lines which foot up to between four and five hundred miles. Their desire has been, in each case, to obtain, with the least possible expenditure, the best equipment which could be installed, to obtain the largest return for the money invested, to develop the business, and give the citizens a service which had not heretofore been obtained with the old systems of tramway work. The syndicate controlling Buffalo is represented there by Mr. Murray A. Verner, of Pittsburgh, a street railway man of large experience in railway work extending over the last twenty-five years. The local interest at Buffalo which has joined in with the syndicate is represented by Mr. Henry M. Watson.

The Buffalo railway property, as will be seen on the map, Fig. 1, which shows all the lines of the company, aggregates about 106 miles of single track, or one-half that quantity of double track, nearly half of which will be new extensions to the old system which was purchased. The heavy black lines shown represent nearly one-third of the system, and is that part which is being installed at the present time. The work on the rest is to follow along just as rapidly as it can be completed, and much of the track is already laid on the other part, which is shown in dotted lines on the map.

The number of cars to be operated on these lines, in the aggregate, will be about 300, which will be mainly 32 and 34 foot eight wheel vestibuled cars.

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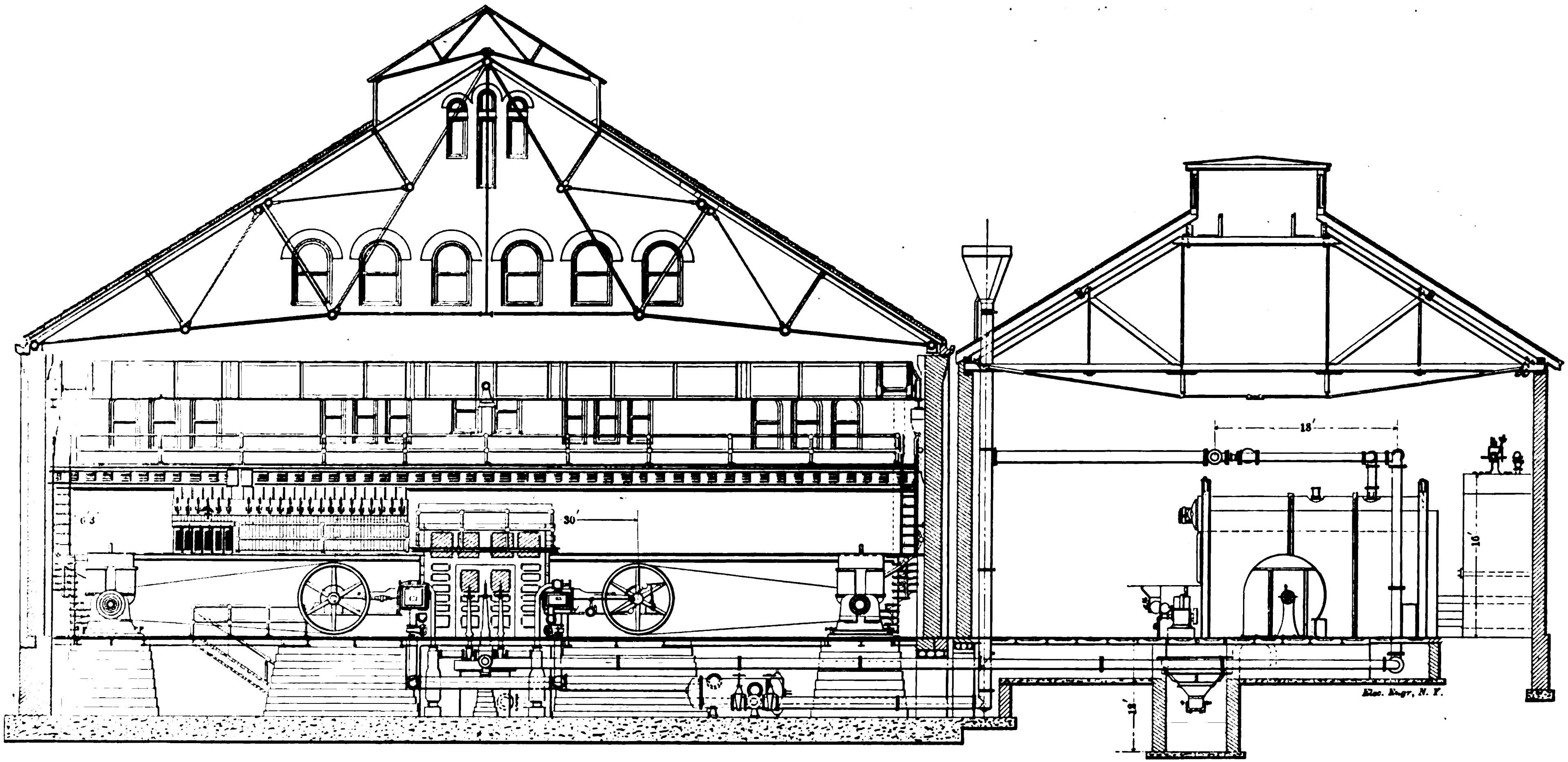


THE BUFFALO STREET RAILWAY POWER PLANT.

FIG. 3.—TRANSVERSE SECTION OF PLANT.

Designed and Erected by the Field Engineering Co., of New York.

The power plant, as shown on the map, is located just above old Fort Porter on the Niagara river, from which water for condensing will be drawn. The plant is laid out for an aggregate and final capacity of 5,500 h. p.

The company's desire and purpose is to obtain in the line work, such perfection and development of the much abused trolley system as will remove from the biased public a prejudice which exists so largely over the country against this system; and this prejudice has been largely due to poor construction and the daily press. Buffalo is particularly adapted by location to have an overhead construction which will be an ornament to the streets, most of the streets radiating from a common centre and the curves in the line being very few; it will therefore present a view which can hardly be surpassed in long lines of well built construction which can be viewed for miles along streets without a single turnout.

About one third of the line will be centre pole construction, with tracks spread to six feet; the remainder will be cross-suspension. In all of the construction the best type of iron poles will be used. In order to make the line more secure, and remove any possibility of cumbersomeness in the overhead work, the feed wires in all portions of the city, except the outlying districts, will be run in underground conduits, the main trunk lines being run from the station in three directions, out of which branch lines are taken as the different systems are crossed, and divided up. By thus placing feed wires underground, we not only add to the reliability of the system in bad weather, but remove many of the prejudices against the same, leaving only the trolley and guard wires overhead. Having thus got a general idea of the system, we will now give a description of the power plant, the details of which are shown in the accompanying illustrations.

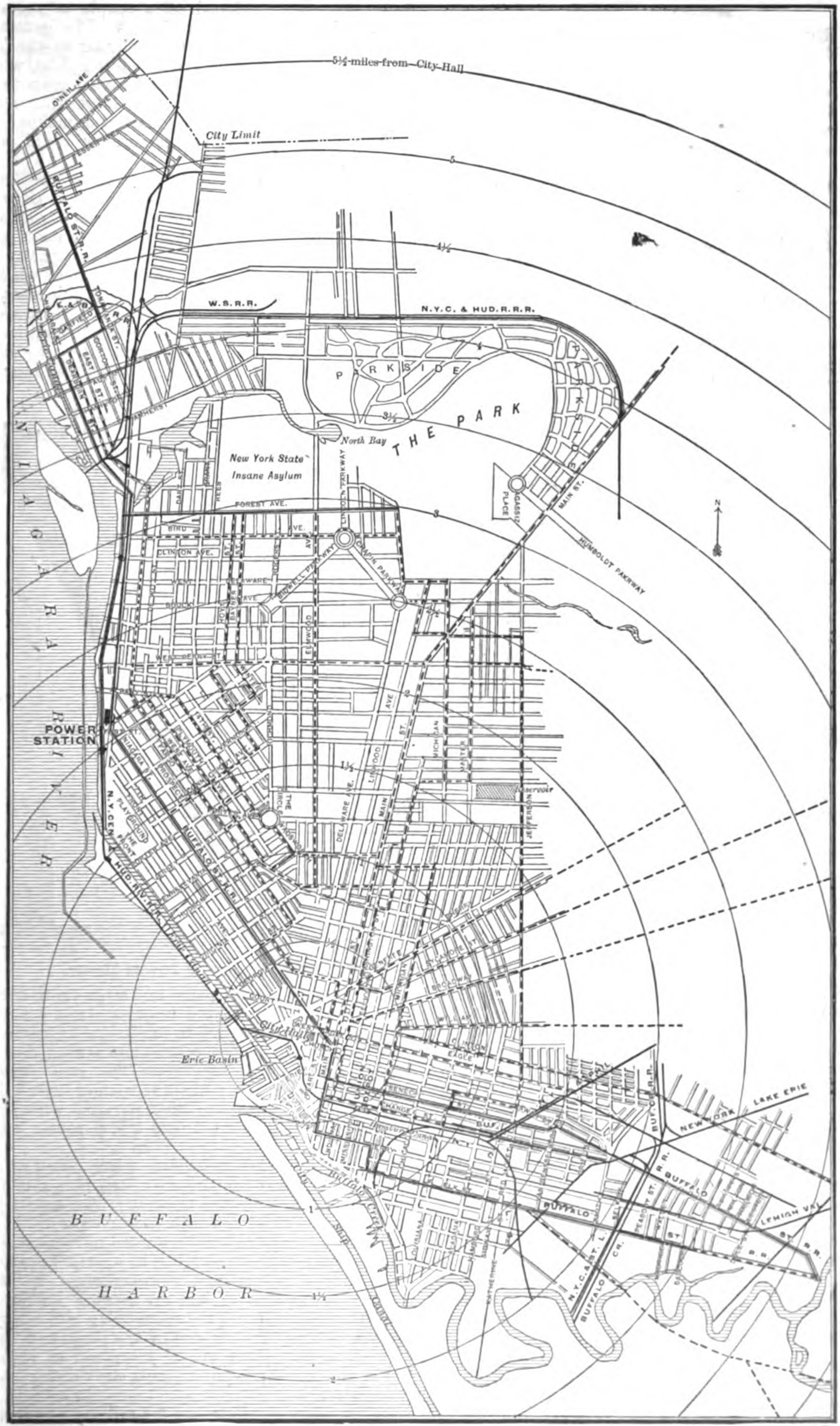


Fig. 1.—Map of Buffalo Street Railway System, Buffalo, N. Y.—Showing Location of Electric Power House and Lines.

Elec. Engr, N. Y.

BUILDINGS.

We have divided the power plant into two separate and distinct buildings, on account of the extended size of the plant, and as a matter of caution and better workmanship. The boiler house, Fig. 5, is a building about 55 x 180 feet, with one-third of the capacity installed at present, which consists of two batteries of Babcock & Wilcox sectional water-tube boilers, with an aggregate heating surface of about 12,000 square feet, and designed to stand a working pressure of 175 pounds. The boilers are fitted for natural and force draft, the stack put up at present being for this battery only; another one is to be built when the remainder is installed. As this plant will be run non-condensing, and therefore feed water will only be brought up to 120° by the exhaust before condensing, fuel economizers have been installed to further raise the temperature of the boiler feed. These are so arranged that the boilers may work either through the economizers, or pass by them in a separate flue, if desired; the blowers installed for forced draft will be used only when emergency may demand. For feeding the coal in the most economical manner for the kind used in this vicinity, Roney mechanical stokers have been installed. Underground conduits leading to the boiler room are used to convey the steam piping. Ash-pits are put under the grate bars, under which is a continuous ash run-way the full length of the building, for convenience in handling or moving ashes. The boiler house is of ample height and dimensions, so that no part of the plant is cramped or crowded in any way. The smoke flue is connected underground to the stack, which is outside the building. The general arrangement of the boilers, etc., is more fully shown on the plan view of the building, Fig. 5.

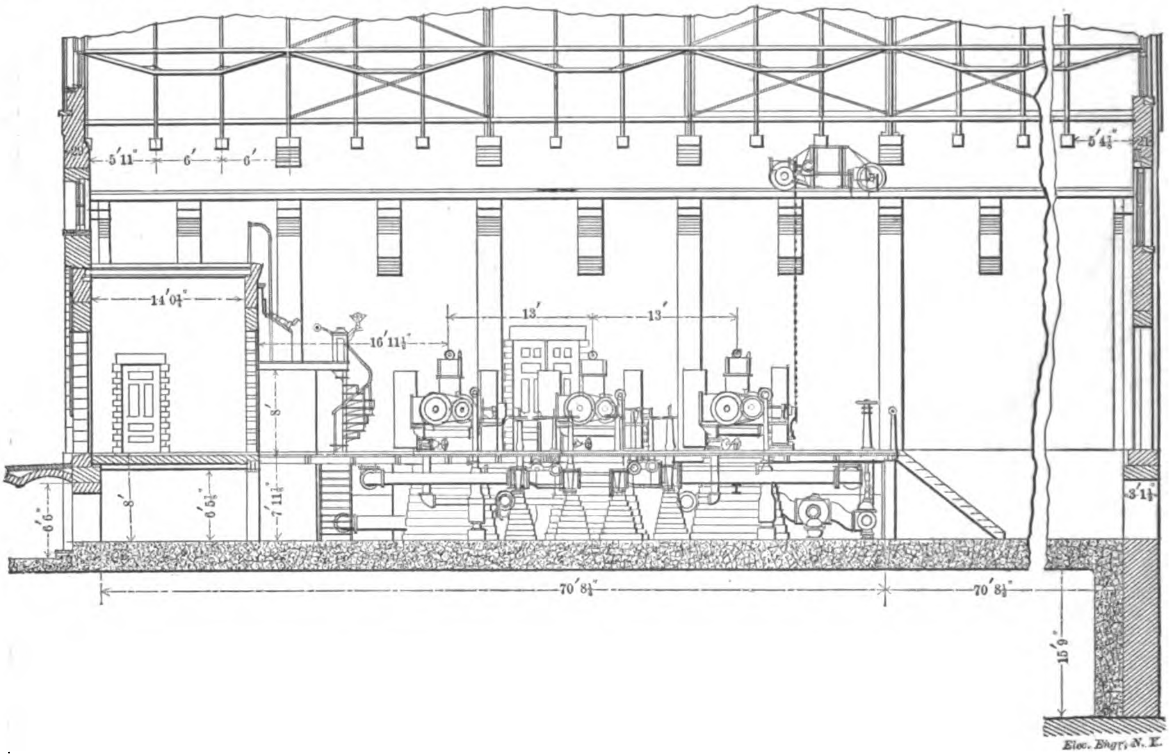


FIG. 4.—BUFFALO STREET RAILWAY POWER PLANT.—LONGITUDINAL SECTION OF POWER HOUSE.

The stack which is installed for this battery is, we believe, a model one, for its size and build, and presents, in the judgment of Buffalonians, the most handsome stack that there is in the city. The size of this stack is 150 feet flue from grate bars to top, with a cross sectional area of 50 square feet. The inside wall extends only 50 feet up the stack, and then there is an offset on the outer walls.

POWER HOUSE.

In the power house proper, Figs. 3, 4 and 5, we have the engines and generators and electrical apparatus in general. This building has inside dimensions of 86′ 11″ x 143′ 10″; in the front part are partitioned off a couple of rooms, one for office, and the other for workshop. The general idea of the architectural design of this building on the front, will be seen in the view of the front of the plant, which is illustrated in Fig. 2. The object here has been to obtain a building which would present a substantial appearance, and be appropriate to the neighborhood, making it at the same time as fireproof a structure as could possibly be obtained.

We have here presented, we believe, the largest and finest power room in the country, having a clear span the width of the building, with iron trussed roof overhead, and a traveling crane spanning the whole room and traveling the whole length thereof, and of a capacity to handle eight tons. The walls of the building are of plain selected brick, with the main walls 20 inches in thickness, and buttresses along the side at every 18 feet. There are no windows in the sides of the building at all, and, looking into the large room proper, only a few at the two ends at the top. Along the side and rear walls, though near the bottom, are placed in each panel two large ventilators for giving fair ventilation of the building from below, without creating any draft through the doors. Overhead, in the roof, we have the louvre so built and arranged as to afford ample ventilation from above. The roof truss is built completely of iron, on which the roofing itself is laid, composed of 3 inch Norway pine, covered with slate. The traveling crane is operated by a 5 h. p. motor, and has two hand trolleys.

The present power installation is composed of six units, consisting of cross compound engines furnished from New York by the Ball Engine Company; the capacity of these engines is 250 h. p., and each one drives a 225 h. p. Edison generator. The plant will be started off with this capacity, and the remainder, up to 5,500 h. p., will be added as required. The foundations, however, are only installed for the present installation, and the flooring is over this part only, the remainder of the room being left empty down to the concrete bed for the rest of the plant to be installed as desired, as this plant will be composed of eight units of 500 h. p. vertical compound, each one driving one or two generators.

In the selection of engines for railway power work there

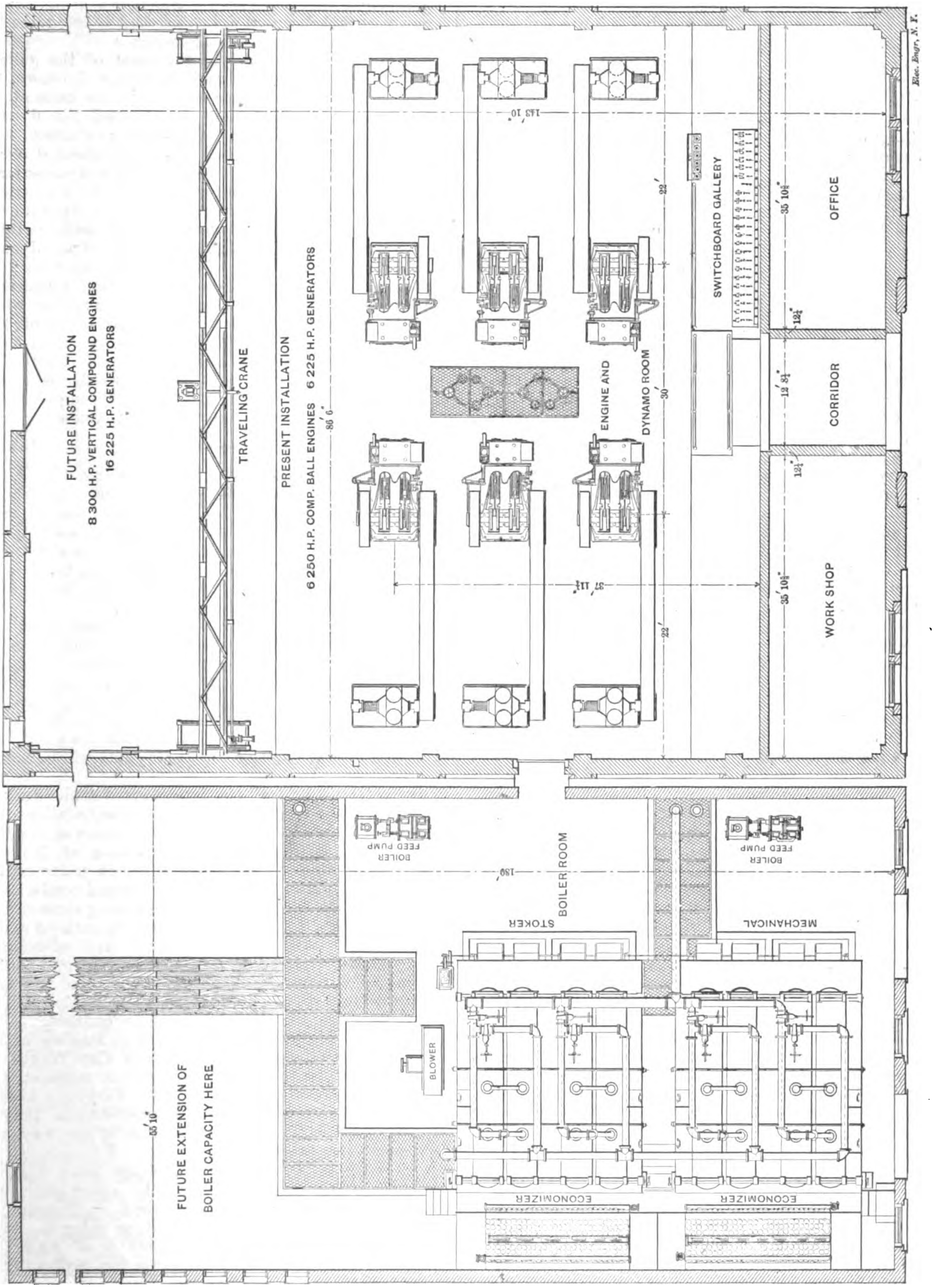


FIG. 5.—BUFFALO STREET RAILWAY POWER PLANT.—GENERAL PLAN.

Designed and Equipped by the Field Engineering Co., of New York.

has been considerable thought expended, as is well known, owing to the hasty work in many places, many errors have been made in the past in the selection and arrangement of proper engine capacity. The so-called high speed engines have, beyond question, in many places received a set-back, owing to some of the engine manufacturers not fully recognizing the needs and requirements of this service as distinguished from electric lighting work. Electric railway work is only to be compared with roll-train service in a rolling mill engine, and should be so designed, and built accordingly, to stand the continuous application and removal of its load. This means heavy, large bearings, strong moving parts, and extra heavy fly wheels.

All of the engines installed in this plant have fly wheels of 15,000 lbs., finished, running at 210 rev's., each engine complete weighing 50,000 lbs. Where high speed engines are built to stand the work in this way, we find them doing nobly, and giving good results and economy, unless we run across some cases where the people have got what may be called a compound craze. By this we mean a craze to install a compound engine, and operate it under such conditions that no economy is being obtained thereby. This is done where they are put in small plants and run non-condensing. Where compound engines have been installed this way, they have, beyond question, given poor results in the majority of cases.

What we are coming to on this kind of work is a vertical cross-compound automatic high speed or Corliss type of engine, and as soon as the electric manufacturing companies in this country have sufficient time to digest the subject, and work it out more thoroughly, the generators will be directly connected to the engine by being coupled right on to the shaft. We are, therefore, in this line of work, getting down to something more practical, and more specially adapted to the work. Where it is possible to obtain them, and get them well built, a unit consisting of one generator to one engine is sufficient, and, in fact, the division of units on any railway plant should only be such as to give economical working under the varying loads and conditions. Where we go up, though, to the larger units as here used, we practically remove one of the principal troubles in smaller plants, that of overloading and overcrowding the units of power.

The steam piping on this plant has been laid out in as complete and comprehensive a way as could possibly be designed, the object being to obtain entire reliability in the furnishing of steam at any and all times. It being impossible to suspend piping overhead, owing to the traveling crane, we have here, in piping under the floor, obtained a better and more perfected arrangement.

The steam piping is installed in duplicate, so that there there are always two sources of supply of steam up to each engine branch. On the iron floor plates shown between the engines on the general floor plan of the plant, Fig. 5, will be seen located the valves controlling the distribution of the steam from either source of supply to any engine, thus concentrating within a small area the valves for handling these. The valve stems, as will be seen, are extended up through the floor, and the handles brought within reach of the engineer standing on the engine room floor. In each engine branch from the main line to the throttle, is installed a water separator for preventing flooding of the engines under any possible conditions. The exhaust piping is arranged to pass through the heater and then to condensers, or free exhaust, as may be required at any time.

ELECTRICAL APPARATUS.

Across the front of the engine and dynamo room, on two sides of the entrance, as shown on the plan, and the two sections of the power house, Figs. 3, 4 and 5, there is situated the electrical arrangement on the electrical gallery. At this gallery the control and operation of the generators through switches and regulators, and also the control of all feeder lines leading into the conduit, is brought under the control of one man, and from this gallery he has a full and unobstructed view of the engine room, so that in any of his movements he can rapidly see what is being done on the floor while he is handling the switches.

First, at the left, we have on the front of the gallery, facing which a man looks down on to the dynamos, the regulator boxes and voltmeter stand. At the back of the gallery behind these boxes, are located the dynamo switches, and along to the right the feeder switches.

As the system to be operated is a very extended one, it was considered desirable to so arrange the dynamos and feeders as to give two different pressures to the outside system if desired. Therefore, above the dynamo and feeder switches is run a double bus-line, with switches placed between, allowing of the connection of any dynamo or feeder into either one of these two bus-lines; on the wall behind are located the dynamo, feeder and main amperemeters. We have, therefore, here a system which gives the greatest possible latitude for operating the plant, and facility for knowing what is going on in every part of it. Under the electrical gallery is located the cable shaft, down which the cables run to the basement, connecting with the dynamos, and also through a vault under the sidewalk with the underground system.

UNDERGROUND CONDUITS.

The underground conduits, as before mentioned, are installed here for the running of feed wires through the main parts of the system. Each line is so arranged as to have its own independent feed wires, one at each trolley wire. These feed wires are connected up to the trolley from the underground at every eight poles, or, in other words, about every 1,000 feet, all connections being made from man-holes.

Two styles of underground tubing have been used here, about one-half of each, namely, the wood pulp pipe of the Indurated Fibre Pipe Company and the cement-lined pipe of the Standard Underground Company. The conduits consist of from two to eight tubes, being 2½" or 3" in internal diameter. Man-holes are located 380 feet apart, thus making convenient distribution for drawing in of cables, and being so arranged that all joints will be located in man-holes.

The best insulated lead and jute covered cables are used throughout in the conduits. In the first installation of 15 miles of double track, there are about 10 miles of conduits, in which will be approximately 40 miles of No. 0000 cable, and to this must be added some 25 miles of feed wires of No. 000, in addition to the overhead conductors.

All the track work of the company is being reconstructed and built in the most substantial manner, with 56 and 60 lb. girder rail with a grooved tread, and with heavy Georgia pine ties placed 2½ feet between centres. Buffalo has a larger amount of asphalt pavement than any other city in the country, and on these pavements the rails are spiked directly to the ties, and the chairs omitted.

There are being built at present a large number of new cars for the company by the Gilbert Car Works and others, but, as yet, the company have not contracted for their electrical car equipments. The work has been so carried out, however, in the line construction that the company is not hampered in its selection in any way, as to the system to be finally adopted.

All the construction work which we have described above, including the buildings, stack, power plant complete, with the steam and electrical equipment, line construction and conduits, has been done under the supervision of the Field Engineering Company, of New York, acting as engineers and contractors for the Buffalo Street Railway Company. Their work covers all to be done in their line, which includes the equipment complete, except cars and track work. The designing of the plant by the Field Engineering Co. has been under the particular direction of Mr. E. F. White, mechanical engineer of the company, and Mr. E. J. Cook, constructing engineer. The construction work at Buffalo has been under the direct charge of Mr. J. B. Craven, one of their assistant engineers. The writer has had the responsibility of the general supervision over the different parts of the work.

We trust the above description, although incomplete, will give the reader a fair idea of the interesting class of work that has here been done, and we know of no work which develops the capabilities of the constructing engineer in this line to a larger extent than in carrying out a contract of this kind.

SOME PRACTICAL SUGGESTIONS ON OVERHEAD CONSTRUCTION OF ELECTRIC RAILROADS.

BY

In the construction of electric street railways, it is most essentially necessary that every detail shall be carried out in the most thorough and minute manner, and to all those parts, each of which has its own special function to perform, must the efficiency of the equipment as an aggregate be looked for. In discussing the best means of carrying out these details, the writer has classified the subject under the following heads:

RAILS.

All rails should be connected with railbonds of sufficient length to span the fish plate and allow a reasonable amount of slack so that the movements of the rail will not cause the bond to break. The rivet holes should be drilled at least two inches from either end of the fish-plate. On girder and T rail this hole should be drilled through the web of the rail, and on flat or tram rail through the flange, and countersunk so that the flange of the wheel will not reach the upset rivet. A rail bond 24 inches in length is usually sufficient for ordinary work. At frogs, switches, curves, or where short pieces of castings occur in the track, these pieces should be connected up in the same manner as the regular rail. It is also advisable to connect these small parts with a continuous wire to insure a good return circuit. At steam railway crossings the track should be connected in the same manner. On single track roads all rails should be cross-connected, in addition to regular bonding with a double headed bond, at every 60 alternate feet. No. 4 B. & S. soft-drawn copper wire is preferable for all railbonds, this offering less resistance than iron wire. On double track roads the same manner of cross-connecting should be observed as on single track, and in addition a cross connection of all four rails should be made about every 300 feet. It is conceded by a number of authorities that a continuous ground wire is not necessary to get a good return circuit.

POLES.

Natural wood poles should be at least 30 feet long for straight line work, with a diameter at the top of not less than 7 inches. They should be of cedar, Norway pine, or chestnut, as straight as possible and free from knots. Octagonal wood poles should be 7 inches in diameter at the top and 12 inches at the bottom, with an untrimmed butt of 5½ feet, which should be tarred before placing pole into the ground. Where wooden poles are used in centre pole construction, an iron shield should be placed around them for a distance of 5 or 6 feet upward from the grade line to protect them from being marred by wagons striking them. Lattice iron or girder poles should be 4 inches in diameter at the top, 10 inches at the grade line, and 11½ inches at the bottom, and at least 29 feet long. These, as well as all other iron poles, should be provided with a thorough insulated pole top. Corner poles should be heavier than side poles. If of wood, they should not be less than 8 inches in diameter at the top. Latticed corner poles should be 6 inches in diameter at the top, 13 inches at the grade line, and 14½ inches at the bottom. It is very important to have strong poles at curves and corners, and for that reason they should be extra long so as to allow of being placed 7 feet in the ground.

POLE SETTING.

For straight line work poles should be set 6 feet into the ground with a rake away from the track of at least 6 inches at the top. This rake will, of course, vary with the width of street, condition of soil, and weight of trolley

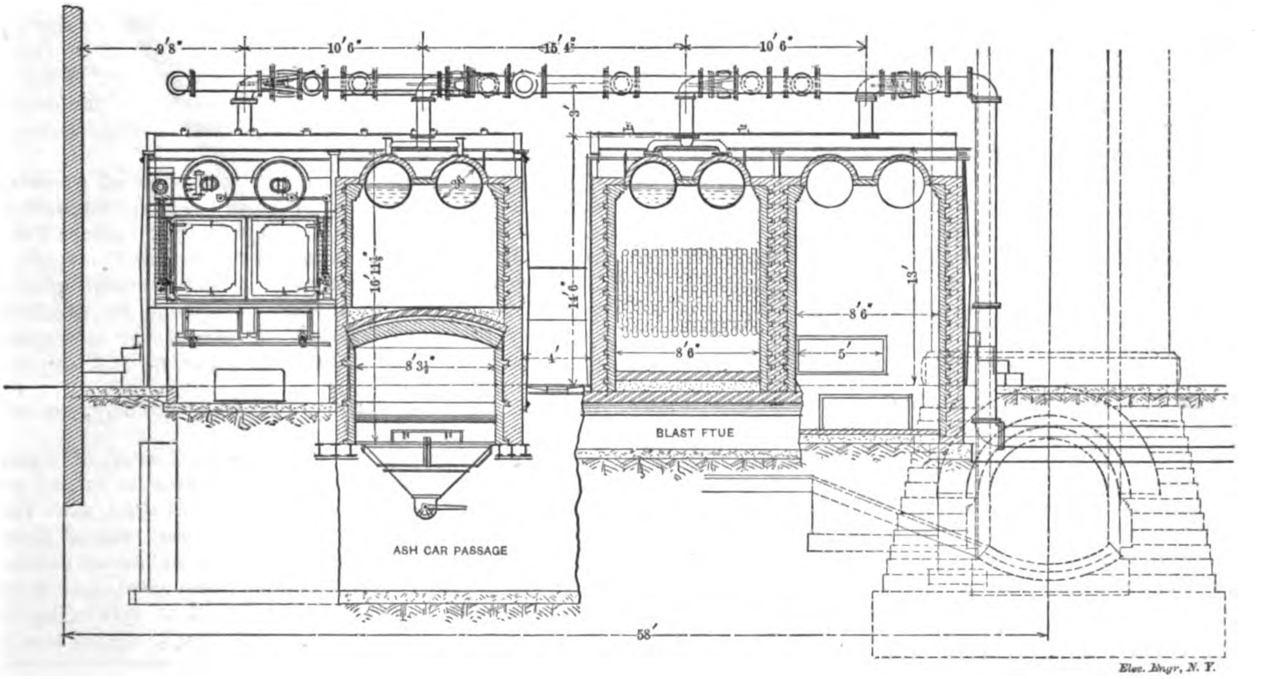


FIG. 6.—BUFFALO STREET RAILWAY POWER PLANT.—SECTION OF BOILER HOUSE.

wire. In setting iron poles a good cement concrete should be used. This concrete should be mixed with small stones and tamped well against the pole. The number of poles required for side construction is usually 88 to 90 per mile, making spans about 125 feet apart. This will necessarily vary with width of street and size of trolley wire.

INSULATORS AND FIXTURES.

Before setting wooden poles, a half-inch hole should be bored at a uniform distance from the top to allow for half-inch eye bolt or ratchet bolt. The use of a ratchet is advised, as it makes it very easy to adjust the trolley wire by simply letting out or drawing up on the ratchet. All insulating pins and brackets should be of best split oak or locust. At points where short turns in heavy feeder wires occur, an iron pin or wooden pin having a bolt through it should be used.

SPAN WIRES.

This wire should be ¼ or $\frac{5}{16}$ inch in diameter, of the best 7-wire steel strands. This is far better than solid iron wire, having much greater tensile strength, and being flexible. The pole ratchets to which these wires are attached should be placed on the poles at at a uniform height from the track, which should be such as to hold the trolley wire at least 18 feet from the track, allowing 2 per cent. of its length for sag.

TROLLEY WIRE.

This wire should be put up in as long lengths as possible. The starting and ending points of this wire should be securely anchored to a strong double span of stranded steel wire, attached to extra heavy end poles. This span should be thoroughly insulated from the poles by means of a heavy strain insulator. The trolley wire should be drawn to moderate tension only, allowing about 18 inches sag to every 125 feet. In cold weather it may be drawn somewhat tighter. Great care should be taken in handling this wire, so as to avoid kinks or scratches.

Curves should be completed as they are reached by the trolley wire. The trolley wire insulators should be clamped on, not soldered, after the line is in place, and all curves are made.

CURVES.

The poles used at curves must be set so they will not give when the strain of the line is placed upon them. The curve brackets should be placed at equal intervals, and it is advisable to solder the clamp to the trolley wire, so as to avoid any possibility of sliding. They should be so placed that the trolley wire may be exactly in line with the trolley on the car. To accomplish this, the curve bracket should be more or less inside of line vertically over the centre of track, the height of wire and radius of curve determining the position. The wire-holding curve brackets should be ¼ or $\frac{3}{16}$ inch 7-strand steel wire same as regular span wire. They should be well secured to an extra strong strain insulator, which in turn should be fastened to pole ratchet. It is advisable to use an insulator where curve bracket wires come to a focus, as this insures additional insulation from the pole. This is particularly the case where an iron pole is used.

FEEDER WIRES.

Great care should be taken in running feeder wires so that they do not become chafed, rubbed or kinked. Where they are run through trees, every precaution should be taken that no limbs or twigs are allowed to lie against the wire, as the swaying of the trees from the wind will eventually destroy the insulation. Where large limbs come in direct line of the feeder, tree insulators should be used.

Feeding in connections to trolley wire should be made through an insulated 7-strand steel cable, this cable serving at the same time as a span wire. To this cable can be attached an uninsulated hanger which at the same time holds the trolley wire.

GUARD WIRES.

Wherever there is danger of crosses with telephone, telegraph or other foreign wires falling on the trolley wire, guard wire should be used. This can be a solid iron wire suspended from either solid or stranded span wire, and insulated from poles by porcelain insulators. By paying special attention to the above points it is thought that the construction will be rendered more simple, and certainly more reliable and durable, giving that constant efficiency and practical working which is the aim of every electric street railway man to carry out in its entirety.

ON THE ARRANGEMENT OF VATS IN ELECTRO DEPOSITION.—III.

BY

C. O. Mailloux.

So much for the theoretical possibilities. Let us now consider the limitations which practice and commercial considerations would impose. The demonstration we have followed above has for its corollary the general conclusion that, other things remaining equal, the cost of power will vary in inverse relation with the *current density*. The practical question which intervenes here, is related to the fact that the character of deposit is to some extent affected by the current density. There is a wide range of current density within which the deposit is of practically constant quality. Any rise above the upper limit of this range gives a "sandy" deposit. On the contrary, if the current density falls too far below the lower limit, the deposit becomes crystalline and unequal, forming what is technically termed "nodules."

In electrotyping, the copper must be of good quality, and of a density midway between the two extremes is desirable. On the other hand, in refineries, where the object is merely to turn out refined copper for the trade, a very low density is allowable. The commercial question involved is related to the size of plant required and the quantity of metal that is in process of treatment at a given time. In the above case, the rate of deposition is reduced to $\frac{1}{n}$ in each vat. Consequently, to obtain n times the deposit, we need, as we found, n^2 vats, which means that not only the plant increases, in initial cost, but that the amount of metal under treatment, also increases, both in ratio n times greater than the rate of deposition. Hence, the practical limit to increased size of plant is soon reached. This is different for each case, and is fixed at the point where the saving effected in power by increasing the plant in the manner indicated, equals the interest on the outlay involved in the increased plant and the increased amount of metal that must be kept under treatment. Beyond that point it is better to increase the current density when increased output is desired.

The theory of the case shows readily, by a glance at equation (4), for instance, that it is important to reduce the electrolyte resistance to the lowest value consistent and compatible with working conditions. This is, unfortunately, what is seldom found realized in practice, merely owing to ignorance of the principles involved. No attention whatever, is usually given to the specific resistance of the solution, and the ratio $\left(\frac{l}{a}\right)$ which has such an important bearing on the economy of power, is left largely to take care of itself. The writer's experience is, that in most cases the depositing capacity could easily be greatly increased, and the *power* consumption *reduced*, by a little attention to these questions.

The question of dynamo efficiency has not been brought into the case in the above discussion. The equations deal, as we see, solely with the power delivered to the terminals of the vats. This may constitute 80, 90 or more per cent. of the energy generated by the dynamo, but it is plain that this percentage can, with a suitable machine, be kept the same for one vat or any number of vats. There is, apparently, much misapprehension as to the E. M. F. required in actual practice for depositing copper. The (London) *Electrical Review* bases its recent arguments on the presumption that 1 volt was the minimum potential difference that could be used per vat. The paper of Captain H. R. Sankey gives for the pressure used per vat, $C(r+R)$, 0.276 volt, or less than 10 volts for 35 vats in series. Gramme gives results showing 0.175 volt per vat, that is, 8.2 volts for 47 vats in series. As an illustration of the range of possibilities in this connection, the writer has deposited good copper with not over .15 volt per cell, while in other cases he has used as much as 5 volts per cell or vat. The first extreme represents *economy*, the second *speed*, of deposition.

There is an equal amount of uncertainty and vagueness as to the limits of current density. It is often stated that the upper limit of density is, for good deposit, about 18 amperes per square foot. The maximum, given by J. T. Sprague, is about 24 amperes per square foot. To illustrate further the wide range of possibility in this respect, the writer can state that he has deposited good copper with densities ranging all the way from a fraction of an ampere to more than *two hundred amperes* per square foot. The latter was not a mere laboratory experiment, but an actual practical result under commercial conditions and for a continued period.

The moral which the reader has doubtless inferred from the above observations is, that the cost of depositing copper will depend on the kind of copper, the speed at which it must be deposited, besides other commercial considerations. It may be well to add, that it will also depend somewhat on whether scientific or empirical methods prevail in working the particular process.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XI.

(Copyright, The Electrical Engineer.)

BY

Herbert Laws Webb

It is important in testing a cable containing a large number of conductors, that the end of the lead be very carefully handled by the attendant who makes the connections, as, if the extreme end is touched or held frequently, the insulation is liable to become sticky and damp, causing an increase of leakage which would naturally be put down to the account of the cable, unless the lead were tried at intervals during the test, and any change in its condition noted and allowed for. A great deal of time also is consumed in changing the connections, unscrewing refractory nuts, tightening them up on the lead, etc. To obviate these difficulties a connecting clamp for joining on the lead wire to the binding posts of underground cable terminals has been devised, and is found to answer the purpose well, time being saved in changing connections, and the end of the lead being thoroughly protected. In Fig. 31, an illustration is given of this clamp in use; the clamp consists of a slit brass socket, the upper part of the socket being hinged and pressed towards the lower by a strong spring. The socket is attached to a hollow handle of hard rubber, and, the end of the lead being bent out straight, it is inserted in the handle, the end of the wire finding its way into a hole in the base of the brass socket, where it is held by a screw. The upper part of the socket or clamp is opened by pressing on the lever, which is faced with hard rubber, so that the attendant who makes the connections has no excuse for touching the lead at any uninsulated spot. In order to change a connection it is only necessary to remove the clamp from one binding-post to another; the pressure of the clamp on the binding-post makes a perfectly good connection, but the lead should be supported at a point near to the cable, or its weight hanging on the end of the connector will have sufficient leverage to force the spring back slightly, causing the upper jaw of the clamp to bear on the edge of the binding-post.

In testing a telephone cable it is advisable always to try the lead for leakage at the end of the test, and also to check the galvanometer constant; it is not unusual in buildings where machinery is sometimes running and sometimes stopped, for the sensitiveness of the galvanometer to vary, owing to the changed magnetic conditions. If the change is considerable and the deflections are regular, it will be noticed at once by the difference in the deflection; if the deflections are irregular the change in the galvanometer will probably be noticed by alteration of the zero, the spot sometimes going off the scale with a run without any apparent cause. After such an indication of altered magnetic surroundings a new constant should be taken at once. Such points as these, however, properly belong to each man's experience, and must be studied and provided for as they arise.

In testing for insulation the greatest degree of accuracy will be obtained by getting as large a deflection as possible; in this way closer readings can be made, and electrification or irregularities are more apparent. If a cable will give a deflection of 300, do not shunt the galvanometer so as to get a deflection of 30, under the impression that closer readings can then be made, as this is by no means the case. With short cables of high insulation it is necessary to employ a very sensitive galvanometer and a large number of cells in order to get a readable deflection, but if possible the battery should always be increased until a deflection is obtained that can be easily read, and that will allow of a certain fall due to electrification without getting within a few divisions of the zero mark.

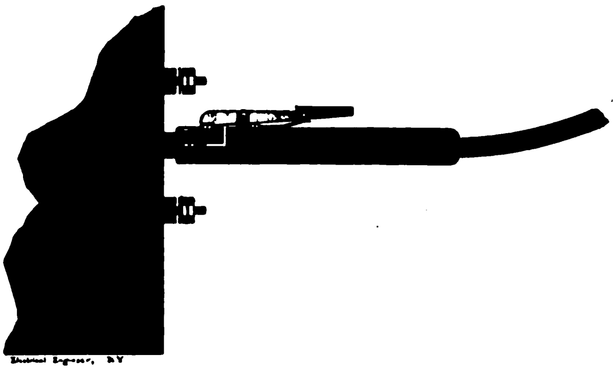


FIG. 31.—CONNECTING CLAMP.

It is erroneously believed by some that the insulation of a wire or cable differs greatly with the tension of the current, testing or otherwise, and that a wire which gives a certain insulation when tested with 100 cells will give a much lower insulation when tested with, say, 500 cells, and that, consequently, tests should always be made with the same number of cells. This, however, is not the case, or at any rate it is held not to be the case by the best authorities; if the insulating material is sound the resistance will be practically the same whether the test is made with 50, 100, 500, or 1,000 volts. Of course with a greater E. M. F. there is a greater current flow, and therefore the deflection will increase with the number of cells. Consequently more battery power may be added with a view to producing larger deflections without any fear of conflicting results from tests made with a lesser or greater number of cells.

It must not be imagined from this, that a test with very small battery power is a good indication of the condition of a wire or cable. Quite the contrary. A wire may show a very good insulation when tested with five cells, although it may contain a fault, or more than one, which the application of, say, 100 cells would reveal very quickly. In the case of a weak or faulty wire, increased E. M. F., therefore, makes a difference, as there may be weak spots in the insulating material which would stand a stress of 5 or 10 volts, but which would give distinct indications of their presence under a stress of 100 volts, and would probably be broken down altogether by 500 volts. For this reason a test made with a battery of only a few cells is valueless, and equally for this reason it is now the custom in many factories to test cables intended for high-tension circuits with an E. M. F. somewhat greater than that which will be used on them in actual working. That they have stood this test once, however, is no indication that they will last good indefinitely and under all conditions, and such wires, whether overhead or underground, should be tested periodically and a close record kept of their insulation resistance; in this way only can warning be obtained of impending trouble, and the economical stitch in time applied at the right moment.

A NEW LINE CONNECTOR AND JOINT.

In all classes of electrical work it is necessary that the line connections at the joints should be as solid as possible and offer a minimum resistance. It is naturally desirable, also, that the making of a joint should be accomplished quickly and inexpensively. The usual methods of soldering are open to objections on the two last points, and moreover in a soldered joint, there is apt to be more or less local electrolytic action or corrosion as two different metals are brought in close contact.

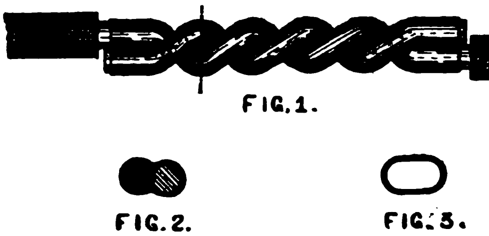


FIG. 1.

FIG. 2. FIG. 3.

A New Line Connector and Joint.

The new line connector invented by Messrs. W. A. Giles and A. M. Hunt, U. S. N., has been designed to overcome both these difficulties, and is exceedingly simple in its construction.

It consists merely of a short, seamless copper tube of oblong section, shown in the engraving, Fig. 3, large enough to contain the wires to be connected, which are inserted side by side.

The ends of the tube are then grasped by clamps, and twisted into the form shown in Fig. 1. During this twisting process, the wires are pressed and rubbed into metallic contact against each other, and the tube is drawn so tightly around them that the connection is practically a solid mass of copper, having even less resistance than an equal length of line wire. No soldering is necessary, and no local electrolytic action can therefore take place. Fig. 2 shows a section of a finished joint.

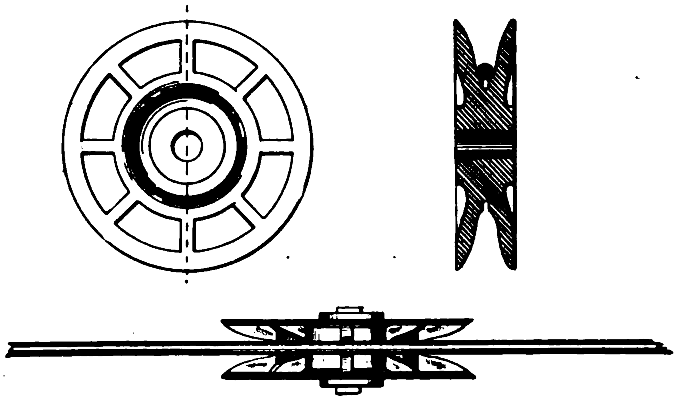
Wires of different sizes can be joined in the same way, as by sufficient twisting the tube can be made to conform to the shape of both.

The little device seems certainly destined to a wide application, not only in telegraph and telephone work, but especially in the distribution of current for lighting and power purposes.

Seattle, Wash. At a meeting of the Home Electric Co., Isaac Dobson, C. P. Stone and others were elected trustees.

THE LEWIS ICE-CUTTING TROLLEY WHEEL.

So much annoyance and loss has been experienced by the accumulation of ice on trolley-wires during sleet storms, that a trolley-wheel which also serves the purpose of an ice cutter, will be appreciated by the managers of electric railways operated on the overhead system. The accompanying illustrations show the Lewis trolley wheel designed specially for this purpose. As will be seen, the flanges of the wheel are provided with ribs which act as cutters and remove the ice from the wire in advance of the point of contact.


Figs. 1, 2 and 3.—Lewis' Ice Cutting Trolley wheel.

One of its principal advantages is that it need not be removed at frogs and switches. It is also apparent that the new arrangement can replace the ordinary trolley wheel permanently, if desired, as it makes an equally good contact with a clear line.

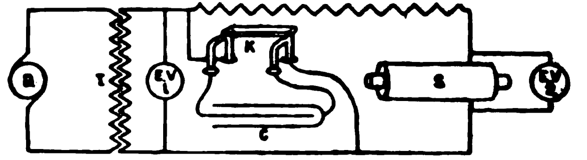
A very satisfactory test of this wheel was made at Seneca Falls, N. Y., during a severe storm on the night of Dec. 17, when the wires were covered with ice to the thickness of from a sixteenth to a quarter of an inch.

The device, we may add, is manufactured by the inventor for the present owners of the patent, the Seneca Electric Co., of Seneca Falls, N. Y.

THE RISE OF POTENTIAL DIFFERENCE IN THE DEPTFORD MAINS.[1]

BY W. E. AYRTON.

I am glad to see that Mr. Glazebrook holds the same view as that given by me to my students some little while ago on this subject. This view was, that when a transformer is used at Deptford to transform up the volts and another one at London to transform them down, the mere fact that the cable connecting these transformers had capacity was sufficient to cause the potential difference at London to be higher than the potential difference at Deptford. In connection with this suggestion some of the students at the Central Institution made a number of experiments last term, under the superintendence of Dr. Sumpner and Mr. Mather. The annexed figure explains



Demonstrating Increase of Potential.

---

[1] *Electrician.*

the arrangement of apparatus used by them for one set of tests, and with a certain rate of alternation, etc., they found on pressing down the double key, *K*, by its wooden cross-bar so as to connect the two coatings of the condenser with the two terminals of the secondary coil of the transformer, that while the potential difference measured by voltmeter $E_1 V$ (volts at Deptford) went up about 1 per cent., the potential difference measured by the voltmeter $E_2 V$ (volts at London) went up over 5 per cent. On raising the key, the potential difference at each end of the circuit went back to its original value, showing that the effect observed in this experiment was solely due to the addition of capacity to the mains.

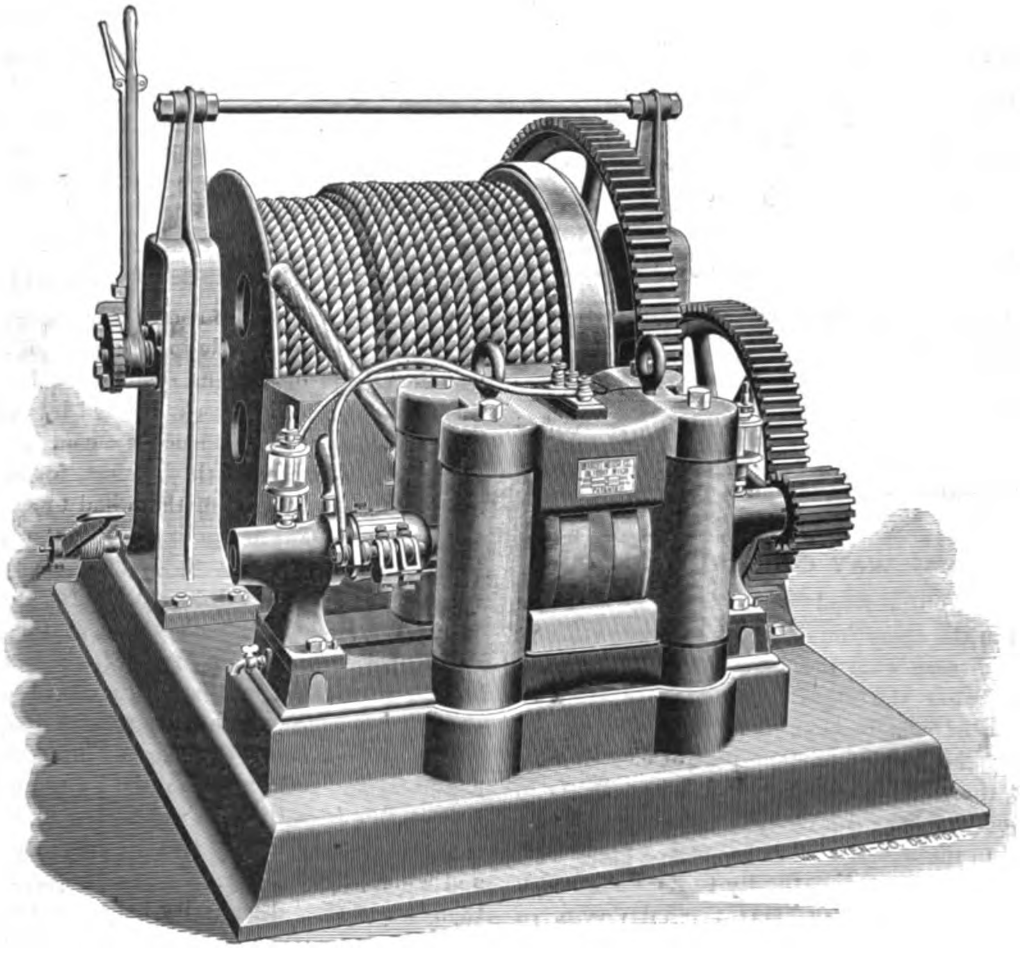
As the secretaries of the Physical Society tell me that they intend devoting one meeting early this next year *exclusively* to the subject of transformers, I will confine myself on the present occasion to the above brief description of this one experiment.

THE ELECTRICAL TREATMENT OF WINE.

For the past twelve months a small 8 horse-power experimental plant, due to M. de Meritens, has been in operation at the Bercy works of MM. Pollet, where M. de Meritens' method of treating wine by electricity has been exhaustively tested and pronounced satisfactory by competent authorities. The dynamo employed is a 25 volt alternator, having a frequency of 116. The wine to be treated by electricity with a view of increasing its "keeping" qualties is passed through a small tube containing a series of silver discs connected to the poles of the alternator. The wine as it flows through the tube is thus traversed by a rapidly alternating current, which it is supposed destroys the ferments. The experimental plant is capable of treating 22 gallons of wine per hour. The process has been tried on wines of all kinds, and the results have been most marked with the light Algerian wines, whose bad "keeping" qualities have hitherto prevented their exportation.

AN ELECTRIC ELEVATOR AND HOIST.

The accompanying engraving shows an elevator or freight hoist built by the Detroit Motor Co., of Detroit, Mich. This hoist is so designed as to bring the switch, the brake and the lever for operating the friction clutch convenient to the operator, so that he may not have to change his position. The side frames, containing the bearings are connected at the top by a stout bar, which prevents them from springing apart when the friction clutch is forced into place. The motor is provided with a raw-hide pinion and all the gears are of standard cut. The resistance box, with the switch for regulating the speed, is fastened to the iron bed plate. This machine is made in two sizes, of five and ten horse-power.



Electric Hoist of The Detroit Motor Co.

FARMING BY TELEPHONE IN IOWA.

Mr. H. C. Wheeler, who is one of the Republican candidates for the next nomination to the Governorship of Iowa, is a farmer of a new kind. Of the actual, downwright drudgery of farm work, Mr. Wheeler knows nothing. He is known in his own country as "the farmer by telephone." This title has come to him because the remote points of his broad acres are connected with his business office by wire, and, sitting in a comfortable chair before an open fire in winter and under an electric fan in summer, he can direct the movements of his hired men without further trouble to himself than the calling of a casual "hello!" Mr. Wheeler farms by telephone. Under these favorable conditions it is not singular that he likes it and that he finds it profitable.

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VOL. XI. NEW YORK, JANUARY 28, 1891. No. 143

The application of science to the arts and industries is to but one purpose, to get the greatest return for a given amount expended.—David Brooks.

ELECTRIC RAILWAY CONSTRUCTION.

THE time is well at hand when it behooves those engaged in the operation of electric railways to look about them and discern what the experience of the past has taught and what the signs of the future are with regard to methods of construction to be adopted. To begin with probably the most important part of electric railway equipment, the power plant, we have no difficulty in recalling the time when the similarity in the general nature of the apparatus in the electric railway power plant with that used in lighting, led most naturally to its installation in much the same fashion. The same general design of high speed engine was employed which had shown itself so successful in electric lighting; but comparatively short experience has demonstrated that a good electric light high speed engine is not of necessity a good electric railway high speed engine. We believe that this is now gradually becoming recognized by competent engineers, and in proof of it reference need only be made to the admirable article by Mr. C. J. Field, descriptive of the power plant of the Buffalo Street Railway, which appears in this issue. Mr. Field's experience has proved to him that the electric railway high speed engine requires a strength and stiffness of parts which must be thoroughly capable of withstanding the shocks which the violent changes of load expeienced in street railway work bring upon it. To this must be added a heavy flywheel capable of storing a sufficient amount of power to accomplish smooth running even with extreme fluctuations. The problem is evidently a simple one which admits of an equally ready solution. The other departments comprising the power plant designed and carried out by Mr. Field are not less interesting and show an arrangement of boiler and electric plant which must develop a high efficiency in operation. The Buffalo Street Railway being determined to have nothing but the best in its work has very wisely started out at once with placing its feeders underground, and the wisdom of this step cannot be questioned by any one watching the course of events and noting the dislike manifested towards overhead wires. We are free to say that with the feeders and mains both placed below the surface of the street, the mere trolley wire will give rise to much less complaint than if the entire system were placed overhead. When we look back upon the work of the past few years in electric railroading and contemplate examples such as that now presented and under discussion, all fear as to the future is dispelled. It is seen that not only the electrician, but the shrewd capitalist, has become convinced that electric railroading is a profitable business and one in which he is warranted in investing millions in order to obtain the best and most economcial results.

THE HEALTHFULNESS OF ELECTRIC LIGHTING.

WE heard recently of some interesting though rather informal experiments made in a couple of Pullman cars to test the effects of various systems of lighting. Some of the officials going into a car lighted by one of the gas systems, sat down in the smoking compartment and shut it up. Their stay was of the briefest, for in a very few minutes even the strongest of them had to succumb to the heat and oppressiveness and to seek the outer air. A like test made in a compartment lighted by electric incandescents was attended by very different results, and it seems, might have been prolonged indefinitely so far as ill effect was concerned. This is not matter for surprise, however, and it may be matched by the experience of people who, being accustomed to the electric light, have had to sit in gaslit rooms, and who have been unable to endure the sense of heaviness and suffocation caused by the gas.

Such things as these do not figure in the estimates one sometimes sees as to the relative cost of gas and electricity, and which, by the way, are less frequent and more exact than they were. Electricity holds its own on economical grounds alone, if we are to believe the disinterested reports from innumerable mills, and other places of large and steady consumption, but the incidental gains are not to be overlooked. Thus, for example, the London *World* reports that a large hotel on Holborn has saved four years' expenditure on repairs and renewals of upholsteries and decorations. The General Post Office in London, moreover, reports that it saved $3,000 last year in sick leaves by the substitution of electricity for gas. The saving would evidently not stop there, for if those who would have fallen sick in an impure atmosphere were benefited by a cleanlier, more sanitary method of lighting, the toning-up effect on the others more robust must also have been felt in their brisker performance of duty.

The only offset to the gain with electric lighting is that which may come from the injudicious use to which people are sometimes tempted by the ease with which it can be brought into proximity to one's work. From what we have seen we believe that a nose attachment for bookkeepers, to carry an incandescent lamp, would be a great success. It is obvious that the heat and glare of a gas jet necessitate keeping it at a respectful distance, but in many an office the naked incandescent can be found swinging an inch or two from the head or hand of the clerk whose work it illuminates. No eye can stand that sort of thing long, and hence the complaints one hears occasionally. The best remedy lies, of course, in a regulation of the distance to which lights are swung or dropped and the employment of the admirable shade devices too well known to need naming. Another remedy not far to seek is a more judicious scheme of lighting for interiors. What is wanted is a distribution of light so even and well balanced that one is not conscious of the lamps but only of the illumination.

OVERHEAD LINE AND TRACK WORK.

It has been remarked elsewhere in these columns that the economical operation of the power plant must to a large extent determine the success of an electric railway, both financially and as a practical system of propulsion, but when we consider the subject in the light of an engineering question more particularly, the fact stands out prominently that satisfactory operation demands a system of track and line work that must be able to withstand all the influences that are brought upon it both by the operation of the road itself and by the elements. Here again it will be admitted that the work of to-day differs materially from that which was thought good enough at the outset. We have indeed been taught that a 35 pound rail will no longer do, but that a 50 to 60 pound rail is necessary to withstand the burden of electric cars and uninvited traffic. Practically the same increase in dimensions and weights has been proved to be desirable in the poles, span wires, trolley wires, and the many accessories which go to make up the complete overhead system, so that to-day electric railway engineers are in position to erect a line which may be guaranteed to stand intact against every ordinary wear which may come upon it. The article in this issue by Mr. A. H. Englund, detailing his experience as to the best type of construction to be adopted, is especially interesting at the present time when a large number of roads are contemplating equipment with the opening of the spring.

THE INVENTION OF THE AXIAL ELECTRO-MAGNET.

The fourth installment of Mr. Pope's biographical and historical paper on the Inventors of the Electric Motor, which appears in our present issue, is of unusual interest. The evidence which he brings forward appears to establish beyond peradventure that it is to Thomas Davenport that we are indebted for the application of the principle of the coil and plunger, afterwards christened by Professor Page the "axial" magnet, to the movement of machinery. This was effected by Davenport as early as 1838, and it appears that prior to 1840 he had built motors on this principle sufficiently powerful to drive a rotary printing-press. The caveat filed by Davenport in the spring of 1838, describing this interesting invention, which slumbered forgotten in the confidential archives of the Patent Office for more than half a century, until exhumed by Mr. Pope, is a document the immediate interest of which is only equalled by its permanent historic value. In addition to this, the correspondence between Davenport and Page upon the subject of the electro-magnetic engine, now for the first time made public, throws a flood of light upon the early researches of both of these able experimenters, and cannot but result in increasing our admiration and appreciation of the indomitable perseverance with which, in spite of limited means, imperfect knowledge, and countless other obstacles, their work was carried on, whereby the foundations of some of the most important industries of the present day were securely laid.

BUILDING FOR TO-DAY AND TO-MORROW.

Since starting its really magnificent campaign for rapid transit, the *Commercial Advertiser* has published a very interesting and ably reported series of interviews with electrical engineers and inventors as to the various problems connected with an underground electric road.

The effect of the unanimity of opinion shown as to the feasible nature of the scheme is seen in the immediate appearance of a plan for a whole series and network of such roads, to be built under the auspices of no less a railway magnate than Mr. Austin Corbin. Whatever may be the ulterior objects of this gentleman, his endorsement of underground electric transit has undoubtedly stamped the project as practical, in the eyes of the public, and has helped on the movement.

The latest interview, printed as we go to press, is one with Prof. Moses G. Farmer, characterised by all the glowing prophetic fervor and canny Yankee ingenuity of that Nestor of the electrical profession. He advises broad, generous plans not merely for to-day but "expecting the population of New York to outrun the present population of London and not need to have the 'darkest spot' in it." He offers the further suggestion that the tunnels may be used for large conductors distributing current for industrial power all along the line. To justify the faith that is in him as to electric traction, he mentions that 44 years ago he built an electric locomotive, equipped it with 48 Grove cells and carried passengers around a little track in the town hall of Dover, N. H. Now he sees the electric railroad running every twenty minutes between Great Falls and Dover, the scene of that early experiment. "I cannot think I am too much expectatious," says the venerable Professor.

An Eight-Column Snow Storm.

The newspapers of Monday morning were full of thrilling accounts of the great damage done by the wet snow storm of Sunday to the electric wires in this city. As many as eight columns were devoted to it by some papers, and the headlines were worth preservation as studies in the picturesque. It is true that a good deal of damage was done, and that among the chief sufferers were the long-distance telephone company's wires, which represent the finest construction in the country to-day—as does all their work. But one hunts in vain for any of the awful disasters that should attend this wholesale exposure of the public to such terrific dangers. The assertion is made that one man was hit on the head with a brick, but it still remains to be proved that a wire did it.

THE FORD & WASHBURN DYNAMO AND MOTOR.

The accompanying illustrations show the dynamo manufactured by the Ford & Washburn Electric Co., of Cleveland, O. As will be seen in Fig. 1, the bed plates and brackets are made in one complete casting. The magnet yokes are of wrought iron fastened to the bed plate, and the pole pieces are separate castings bolted to the magnet yokes. The field cores are wound on separate shells, and are interchangeable for all machines of the same size. The armature shaft is of steel and of extra large size.

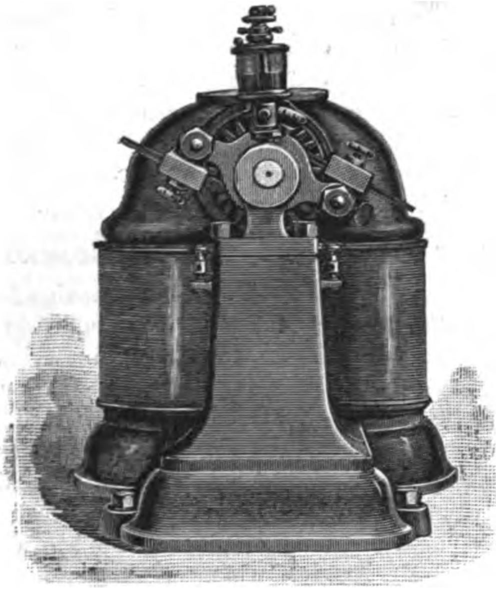

Fig. 1.—The Ford and Washburn Dynamo.

The special feature of this machine, however, is its self-ventilating armature. As will be readily seen from the engraving, Fig. 2, the discs, of which the armature is built up, are spaced, and the winding is separated, thus allowing a current of air to enter at the ends of the shaft, and having traversed the armature, to leave it radially, as shown by the arrows.

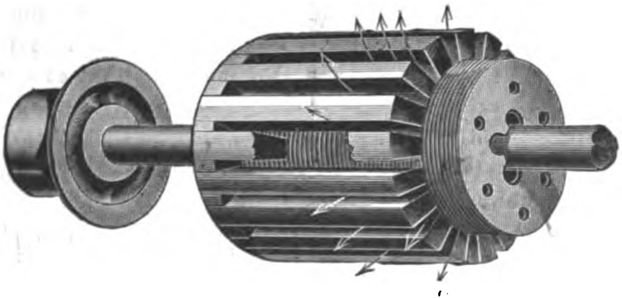

Fig. 2.—The Ventilated Armature.

Mr. Washburn, the electrician of the company, has also invented a storage battery, in which the lead plates are replaced by walled chambers, so constructed as to afford the freest circulation to the solution, the electrodes being separated by a porous non-conducting diaphram. The battery is exceptionally compact, and is claimed to be to all intents and purposes electrically indestructible.

Certificates for War Operators.—In the House of Representatives last week, Mr. Osborn called up and advocated a bill authorizing the issuance of certificates of service to telegraph operators who were with the Union Army during the war of the rebellion. Mr. Cannon inquired whether this was not a step towards granting these men pensions. Mr. Osborne gave an emphatic denial. The bill was passed, yeas 135, nays 82.

PRIORITY IN THE PRODUCTION OF ALUMINUM BY ELECTRICITY.[1]

BY PARK BENJAMIN.

In a dispatch dated Lockport, N. Y., Jan. 19, Mr. Eugene H. Cowles is reported as saying that the Cowles patents for the production of aluminum "cover the use of electrical energy in its broadest sense, whether it be used to produce heat or to act electrolytically." It would not be necessary to refute an assertion so incorrect as this were it not a fact that perhaps more inventors and more capitalists are now interested in the solution of the problem of cheap aluminum than ever before, and the fact of such a claim publicly made and left uncontradicted can only be to retard the work of the one class and to check the fostering interest of the other.

The earliest patent on the Cowles process is dated Aug. 18, 1885, and it describes a method of producing aluminum which consists in reducing an ore or compound of aluminum in company with a metal by means of electricity and in the presence of carbon, so that an aluminum alloy is formed, from which alloy the aluminum is afterward separated. The claims in the patent are to this process, and, so far from "covering the use of electrical energy in the broadest sense," the patentees themselves in their own specification say: "We are aware . . . that the alkaline earths have been reduced by electrolysis in contact with an alloying metal and plates of carbon or platinum, and the alloyed metals thus produced subsequently separated. We do not, therefore, claim the same broadly." This in itself is sufficient to meet the statement that Mr. Cowles is reported to have made. But perhaps a few words as to the prior state of the art may be added.

Aluminum was reduced from its chloride by electricity by Henry St. Clair Deville, the very eminent French chemist, in March, 1854, and was fully described by him in the paper presented to the French Academy of Sciences on Aug. 14, 1854, when he exhibited bars of aluminum thus made. Napoleon III. at once became greatly interested in the subject, inasmuch as he perceived many military uses of the metal; and he at once supplied the funds for further investigations by Deville. The first object made of pure aluminum was a rattle for the Prince Imperial, and the metal was exhibited at the Paris Exposition of 1855 as "silver produced from clay." In the same year with Deville, Bunsen described a similar process of electrolytic extraction in Poggendorf's "Annalen."

In 1859 Deville published his treatise "De L'Aluminium," and this work contains a complete account of his electrical processes, with pictures of the apparatus. Subsequent to Deville and Bunsen and before Cowles came the electrolytic processes of Le Chatelier, 1861; Monkton, 1862; Gaudin, 1869; Kargenbusch, 1872; Berthaut, 1879, and Gratzel, 1883, all of these people working on the electrolysis of fused aluminum salts. Besides these there were a large number of inventors who patented processes of obtaining aluminum by the electrolysis of aqueous solutions. Prior to the Cowles patent four United States patents were granted for the electrolytic extraction of aluminum, the earliest dated 1880.

The public may, therefore, understand that the "use of electrical energy in its broadest sense" for the extraction of aluminum does not belong to Mr. Cowles or to anybody else, and that it is free to any one to electrolyze aluminum solutions of fused aluminum salts, and to patent new processes and apparatus for the extraction of aluminum by any electrical means, subject only to the patents for the specific processess and apparatus now in force.

THE ELECTRICAL ENGINEERS AND THE "HENRY."

At the 53rd meeting of the Institute, held at the house, 12 W. 31st street, the evening was devoted to the thorough discussion of Mr. Kennelly's paper on "Inductance and Its Proposed Unit, the 'Henry,'" also the report of the committee appointed to consider the proper magnitude of the unit. The report of the committee was finally adopted, and is as follows:

At a meeting of the American Institute of Electrical Engineers, held September 16th, 1890, a committee consisting of Dr. Wm. E. Geyer, Dr. Louis Bell, George M. Phelps, Edward A. Colby, and Francis B. Crocker, chairman, was appointed to consider and report upon the best value for the "Henry"—the proposed practical unit of self-induction or inductance.

After careful consideration, the Committee has reached a conclusion and now recommends to the Institute the retention of the present value of the practical unit, which is 10^9 absolute units of inductance, usually expressed as a length equal to one earth's quadrant or 1,000,000,000 centimetres.

The Committee finds that this value is too high in some cases for convenience, as many practical measurements of inductance would have to be expressed in fractions of a henry. At the same time other practical values would often amount to a number of henrys, and sometimes to hundreds or even thousands of henrys. It is, of course, impossible to have a unit fit all cases, and in this instance it happens that the average practical inductance would approximate one henry in value. This may be considered fortunate. Small values may be conveniently expressed in milli-henrys, analogous to milli-amperes, etc.

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[1] Letter to *New York Times* of January 21, 1891.

The Committee is of the opinion that even if the value of this unit (10^9 absolute units) had been much less convenient than it is, nevertheless it would probably be very unwise to change it, for the reason that it is derived from and related to the other practical units in the ratio of one to one, just as one ampere is equal to one volt divided by one ohm. To depart from this plan which has always been followed heretofore, would tend to destroy the harmony of the entire system of practical electrical units. The same fact made it necessary to define the farad as a capacity of one coulomb at one volt, although this makes its value so enormous that the micro-farad is always used in practical work. It appears, therefore, to the Committee that the value of the "henry" should certainly be fixed at 10^9 absolute units of inductance.

FRANCIS B. CROCKER, Chairman.

The paper and report were freely discussed by Dr. Cary T. Hutchinson, T. Wolcott, T. Reid, C. O. Mailloux, Prof. Crocker, A. E. Kennelly, C. Steinmetz, and others.

THE COMMERCIAL RATING OF ELECTRIC GENERATORS.[1]

BY THOS. G. GRIER.

GOOD engineering requires that specifications should have their aims, objects and purposes defined with accuracy. The generator of an electric light or power plant is one of its most essential features, and in defining or in rating its capacity we should do so in terms that have a tangible meaning.

The standard electrical units by which electric light installations may be specified are the ohm, volt, ampere, and candle-power, and in electrical power installations, the same, substituting the horse-power for the candle-power.

Instruments for measuring the ohm, volt and ampere, have been adapted to the necessities of practical engineering and when these three units are the basis of a specification it is with comparative ease that an expert can ascertain the correctness of the work.

In the majority of specifications and contracts, as now drawn, the capacity of the wiring will be for so many 16 c. p. lamps, or for so many h. p. motors, and the generator will be rated in so many 16 c. p. lamps or for so many h. p. motors. This use of the units candle-power and horse-power virtually means nothing.

The arc lamp of so many nominal candle-power is another unit which means nothing when applied to the capacity of the machine.

The candle-power unit is, in a measure, open to criticism on the ground of inaccuracy, but in this discussion the discrepancies that may exist in the several standards are not the points to be considered. The candle-power unit is a unit of light. Our generators do not produce light, but electrical energy. Our arc and incandescent lamps convert the electrical energy into light and heat. The horse-power is the unit of power. Our generators do not produce the power, but our motors utilize the electrical energy and convert it.

Before considering why we should not use the terms, candle-power and horse-power, in rating our generators, even though these terms are perfectly correct, we will discuss the converting apparatus, that is, the incandescent lamp, the arc lamp and the motor.

The incandescent lamp being an apparatus for converting electrical energy into light with an unfortunate side product of heat does not give back 100 per cent. of the electrical energy as light, nor does the proportion that produces light and the proportion that develops heat vary in the same ratio under different conditions. Lamps are in use to-day that vary in the consumption of energy per candle-power produced from 3 to 7 watts, and even as low as 2 watts has been claimed. This variation in the energy when the lamps are of the same voltage means a variation in the amount of current necessary to produce the equal amount of light. Recent experiments made upon lamps bought in the open market show conclusively that lamps of the same rated voltage and candle-power are not uniform. Here are a few instances of the variations of the amount of current required.

1. Twenty lamps, 10 each of two different makes, were placed upon ordinary commercial meters and were burned for the same length of time. To eliminate the errors of the meters they were transposed so that each set burned an equal time on each meter.

The result of the experiment showed that there was a difference of 27 per cent. in the amount of current consumed between the sets.

2. Another station tried the same experiment using one set of lamps of a different make from that of the former and one set of the same make. The result of their experiment was a difference of 22 per cent.

3. A station operating some 700 lights had a number of the nominal 16 c. p. lamps that were in use tested and found the candle-power to range from 17 to 22. On discovering this, nominal 10 c. p. lamps were used and called 16 c. p. As the current was sold by meter, the customer was in no way injured by the substitution.

4. A number of large lamps were tested and nominal 100 c. p. lamps were found to give from 44 c. p. up to 110 c. p.

5. In December, 1890, tests were made on four different makes of lamps. All the lamps were marked by the manufacturers at the same voltage and all were nominal 16 c. p. lamps. The tests showed a variety of candle-powers ranging from 11 up to 24 and efficiencies from 2.46 watts to 4 watts per candle-power.

6. A large lamp of new make of nominal 150 c. p. gave an efficiency of 2.4 watts per candle-power. As this was the most efficient of any lamp tested it has been placed on the circuit of a central station and is undergoing a life test.

These experiments are of considerable value in this place as proofs of the desired end in view, as they show that when capacity is given in candle-power, it means only an approximation. We should not, however, draw conclusions as to the real commercial value of the lamps tested. The durability of a lamp is a most important factor, and without a test as to the life of the various lamps and a mathematical equation being deduced that would include life, efficiency and cost of lamp, no actual commercial conclusion should be drawn. It is a well-known fact that the life of a lamp is dependent upon the efficiency at which it is run. A lamp can be made to produce light commercially at an expenditure of energy varying from 2 to 7 watts per candle-power.

The factors that govern the efficiency at which the lamp should be run are, the cost of producing the electrical energy and the cost of the lamp. From this view of the matter, even though the lamps were uniform, it is possible to have conditions wherein would exist a difference of over 100 per cent. in the amount of current necessary to produce equal amounts of light.

When a specification requires that an incandescent dynamo should have a capacity of 100 16 c. p. at 110 volts, what does it mean? Must the machine be capable of producing energy sufficient to operate lamps at 7 watts or but two watts per candle-power? Must it develop 30 amperes or about 102 amperes? Either machine is within the range of the specification, the efficiency of the lamps governing entirely the size.

If nothing further than the capacity in candle power is specified what right would the purchaser have to grievance, or redress, if the machine of the smallest limit, that is, 30 amperes, were sold to him as a 100-light machine, his lamps requiring more than 30 amperes?

The arc lamp is also an apparatus which converts our electrical energy into light and heat. Its efficiency, when the lamp is well adjusted and cared for, should not vary to any great extent. Bad adjustment is a fruitful cause of poor efficiency and good adjustment can not be maintained without good regulation. To measure the candle-power of an arc lamp is not the easiest matter in the world and for one to attempt to judge by the eye is an absurdity. In tests that have been made on arc lamps the results were from $\frac{7}{10}$ of a horse power up to $1\frac{4}{10}$ horse power per lamp of 2,000 candle power, so called. These figures were based upon the difference between the total horse power exerted by the engine and the horse power of the engine running empty, and the belt thrown off the dynamo.

As the actual candle power of the lamp could not be measured it remains still a matter of conjecture whether the machines were really of so many 2,000 c. p. lamp capacity.

The electric motor is another apparatus for transforming electrical energy into different form. The efficiencies of the various motors on the market vary from 90 odd per cent. to as low as 50 per cent. and perhaps lower. Their efficiency also varies with their speed and load. The generator for a 10 h. p. motor could mean a machine capable of generating anywhere from 11 h. p. up to 20, depending entirely upon the economy with which the electric motor utilizes the energy supplied by the generator.

The question of rating the machines in the units which measure the work of another piece of apparatus is merely rating the machine upon a variable standard, that is, the efficiency of another machine. We do not rate our engines in the capacity of the dynamo but upon a unit of its own, the horse power giving the speed and pressure at which this horse power is developed. The boilers, however, are rated in the unit horse power, which unfortunately is as great a mistake as the rating of dynamos or generators in any other unit than that of the form of energy which is directly produced by them.

The transformation or the conversion of any form of energy to another must take into consideration the efficiency of the conversion. In transmitting energy from the point of production to the point of consumption a loss is entailed. To convey electrical energy for light and power we use a metal conductor. The size of this conductor is not dependent upon the amount of horse power developed or the amount of candle power developed, but upon the amount of current transmitted and the amount of pressure. It is within the limits of possibilities that the current to develop the same amount of light or power may be, in one case, double what it would be in another, owing to the difference in efficiency of the converting apparatus.

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[1] A paper read before the Chicago Electric Club.

Another point to consider, besides the efficiency, is the resistance in the conductor. In some cases where fuel is extremely cheap a large percentage of the energy may be used in transmitting the power and, consequently, the generator would require an increased capacity in proportion to the percentage that is lost.

Tables for the use of wiremen have been prepared by the various companies, and while speaking of the generator, it is just as well that attention should be called to the tables. The units used as a basis for their determination are the horse power and the 16 c. p. lamp. It is apparent that a wire to carry a 16 c. p. lamp, or a horse power, with a certain percentage of loss, does not even mean an approximation, the variable conditions that exist giving the expression only a very general meaning.

The lamps or the horse power are assumed to take a certain amount of current and though the calculations are correct, the entire table depends for its accuracy upon how near the assumption approaches the actual efficiency of the apparatus used.

The capacity of the generators should be specified that measure the energy in the form in which it is developed. Dynamo electric machines develop or produce electrical energy measured in volts and amperes. The carrying capacity of wires for the transmission of this energy depends upon volts and amperes. The candle power and horse power have nothing to do with it. Electrical generators should have their capacity specified in volts and amperes or in watts giving the pressure in volts at which this specified power is produced. The sizes of the wires should be determined upon the basis of amperes and volts, stating the percentage or number of volts lost in transmitting the current. The English manufacturers give the capacity of the dynamo in watts and a purchaser, even though he be ignorant of the first principles of electric machinery, could, with little trouble, determine whether he had received the dynamo capacity he had paid for. But were the rating in candle power or horse power the results could not be so satisfactory.

The Edison Co., in the United States, and several others of the larger electric manufacturing companies give the capacity of their various generators in watts but the agents and contractors seem invariably to overlook this and propositions and contracts are drawn up with the generators rated in the indefinite terms, horse power and lamps or candle power.

Why the Americans have adopted tho candle power and the horse power as a basis of rating electrical machinery and the compiling of wiring tables is perhaps apparent to many, and the reasons were no doubt at one time good. It is, however, obvious that this general use of these technical terms is entirely wrong and the electrician must be the means of reorganizing the system. The tendencies are in the direction of this needed reform but the change cannot be too rapid.

The fundamental principles of Ohm's law are thoroughly familar to the intellegent workman and the sooner our calculations are confined to mathematical accuracy and our generating machinery rated in the proper units the better for the electrical business.

NOTES ON THE ELECTRIC RAILWAY: HISTORICAL, STATISTICAL AND TECHNICAL.[1]

BY F. L. POPE.

FEW people have any conception of the enormous extent of city and suburban traffic in the cities of the United States. A few statistics are more impressive than pages of rhetoric. The official returns show that during the year ending Sept. 30th, 1889, the 110 street railways in the state of New York carried over 686,000,000 passengers, or 100 times the total population. In New York city alone the surface and the elevated roads carried together about 400,000,000. In Boston, 100,000,000, and in Philadelphia, 150,000,000 passengers were carried. In fact, statistics indicate that the street railways of the United States carry something like twice as many passengers as all the steam roads, and moreover, it has also been found that the number of passengers increases from year to year in a much greater ratio than the population, which means, not only that more people ride, but that the same people ride more frequently each succeeding year.

The transportation of this enormous number of passengers; probably not less than four or five billions, taking the whole country together, with safety, comfort, speed and economy, must be recognized as an undertaking of the most gigantic description. It is well worth our efforts to carefully consider the best means by which it can be accomplished. No work has ever been done by the inventor, the engineer or the electrician, of such immediate and direct benefit to the masses, as that which has to do with the subject under consideration.

Mr. Pope here dwelt briefly on the nature of the three methods of overhead, conduit and storage traction, and then in a very interesting manner gave the details of the work of Thomas Davenport and Page, exhibiting a copy of *The Electro-Magnet*, a little weekly paper printed by Davenport in this city just fifty years ago. After pointing out the impossibility of achieving any great result with chemical batteries as the source of power, Mr. Pope came to the invention of the dynamo, the discovery of its reversibility, and the dawn of the modern era of electric power transmission. He then called attention to the very early work of Stephen D. Field, and to that of Joseph R. Finney, who brought out his overrunning trolley at Pittsburgh in 1882. Mr. Field had in his original plans proposed the use of a conduit, and that method was to-day being eagerly pushed to perfection.

Mr. Pope then dwelt upon the many desirable features of storage traction, but showed that the main objection was a financial one, a storage car mile costing 10.6 cents, or about the same as horses, while the overhead system reached only about 5.09 cents per car per mile. As to the results of storage battery operation, Mr. Pope reviewed the expert tests made by himself in 1886, for President Whitney, of the West End road, of Boston.

Coming to the question whether electric railways are dangerous, Mr. Pope said:

With a view of getting at the actual facts in the case, the *Boston Advertiser*, a few months ago, sent out a circular letter asking information from every city in which electric railways are in actual operation, from Portland, Me., to Galveston, Tex. It was asked what system was used in each place; whether there had ever been loss of life or injury from the wires; whether there was any serious objection on the part of the public to overhead wires, and what was the general opinion in the locality as to the effect of the introduction of electricity upon the street railway service? Replies were published from 64 cities and towns. All but four of them were favorable. Not one solitary instance of accident or serious injury from electric currents was reported. One of the objecting places was Newport, R. I., where it seems the "upper ten" strenuously opposed the introduction of anything that would popularize riding on the streets.

An extraordinary amount of nonsense has been printed and talked in respect to the alleged dangers of both electric light and railway wires. The public have been needlessly alarmed by the exaggerated statements of interested parties, but, nevertheless, the danger is so small, as a matter of fact, that the actual figures are almost astonishing. Most of the accidents which have been reported occurred in New York city. Yet the statistics show that in 1889, out of 1,467 deaths in New York city, by accidents of various sorts, only *nine* were due to electricity, a considerably less number than were killed by being run over by horse cars. Not a single death was recorded in Boston, although there are perhaps more wires there in proportion to the population than in New York. There are in the six New England States nearly 140 arc light stations, burning over 20,000 arc lamps and distributing 30,000 horse-power of electricity through the streets of the principal cities and towns. During the last ten years, so far as I can ascertain, there have been but *five* deaths from electricity; four of these were employés of the lighting companies, and one was a careless boy who climbed upon a shed and took hold of a wire. During the same ten years the steam railroads of New England have killed 2,339 employés and 2,902 other persons! 5,241 against 5. Not only is electrical power far less dangerous than the same quantity of power used in other industries, but it is relatively safer, as the few accidents that do occur are among the employés. These remarks refer to electric wires in general. Now as to electric railway wires:

I believe that it is an incontestable fact that not one single man, woman or child has ever been killed or even seriously injured by a 500 volt current, which is the highest pressure ever permitted upon electric railway wires. Every alleged case of accident by railway wires has, upon investigation, proved to be either without foundation, or to have been caused by an electric light current. When we consider that shocks have been experienced by men, women and children; persons of all ages and all sorts of physical conditions, sometimes for a period of several minutes, experience seems to warrant the positive assertion that the electric railway current is not dangerous to human life, and that we may dismiss that question from further consideration.

Many persons are alarmed at the vivid flashes of light which are often seen at night beneath the wheels of an electric car, and at the point of contact of the trolley wheel with the overhead wire, and are under the impression that they must indicate a very dangerous electric pressure. Such, however, is not the case. In an electroplating establishment at Ansonia, Conn., I once saw a workman accidently set a tin pail filled with water upon a pair of electric conductors near the dynamo. The pail instantly disappeared, being not merely melted, but being converted into metallic vapor, with a terrific flash which illuminated the whole building with a dazzling and instantaneous radiance; yet the current which produced this startling phenomenon was of such low pressure that it was impossible to detect its presence by the sense of touch, even by applying the hands directly to the bare conductors.

The average speed of the horse car is about six miles per hour. The question is sometimes asked: How fast may electric cars be safely run in a city street? One fact within my own knowledge will go far to answer this question. There is a heavily traveled street in Pittsburgh only 36 feet wide, containing a double-track cable road, which leaves not more than nine feet space on each side. At first the cable cars were run at the rate of seven miles per hour; afterwards the speed was increased to nine and one-half miles per hour. The records show that there are not so many accidents under the present arrangement as there were before. Pedestrians and drivers are more careful and take fewer chances. The schedule rate of the electric cars in Cleveland is nine miles per hour, and in some parts of Boston as high as 12. The value of an electric railway to the public is largely determined by its speed, but the economical aspect of the question is equally important. If we make six miles per hour with horses, and nine with electricity, each car does 50 per cent. more work without increased expense for conductors' and drivers' wages, which is an important item. Another economical feature due to the use of electricity, is the ability to haul one, or even two tow cars without loss of schedule time on special occasions when the traffic is unusually great.

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[1] Abstract of paper read before the New York Electric Club, Jan. 22, 1891.

Nothing is more astonishing than the capacity of the electric cars to make their schedule time in the face of the heavy storms of a New England winter. It is a common sight to see an electric car running apparently with perfect ease up a heavy grade through snow a foot deep, pushing or pulling other cars loaded to their utmost capacity.

The total number of electric cars now running in this country is probably between 2,500 and 3,000. Of the whole number, I presume not more than 30 or 40 are operated by storage batteries. The fact that the overhead system, though introduced at a later period than either the storage system or the underground distribution system, has so far surpassed them both, goes far to show that as yet it is the only system which has been able to meet the various exacting requirements of our street railway service.

Mr. Pope then spoke in terms of praise of the work of C. J. Van Depoele, Leo Daft and F. J. Sprague, and closed as follows:

The limits of time compel me to content myself with the briefest possible reference to the most important development of electrical transportation which has yet come before the public; the electric underground railway. This undertaking having been placed in the hands of electrical engineers whose competency cannot be questioned, and backed by ample capital has proved in London a phenomenal success. We are now assured that a syndicate of the most prominent capitalists of New York have undertaken to establish a system of transportation upon the same plan, consisting of a network of tunnels at a depth of 100 feet beneath the surface, and connecting all important points not only in the city itself, but in the adjacent sections of Long Island and New Jersey. In such a system it necessarily follows that the train must be run by electricity to the exclusion of any other power.

Every thoughtful person realizes that something must be done at once, not only to relieve the congestion of traffic which already exists in the streets of New York, but to provide for the enormous yearly increase which must be taken into the account. Statistics show that the traffic of the horse cars and elevated lines in New York has increased 46 per cent. within the five years from 1884 to 1889. A careful estimate which has recently been made of the movement of passengers in and about New York during the year 1890, gives the following amazing results:

New York city (surface and elevated roads)..	400,000,000
Brooklyn Bridge..............................	38 000,000
Long Island Ferries..	90,000,000
Staten Island and New Jersey Ferries........	85,000,000
Total..........	603,000,000

If the profit derived from carrying these passengers amounts to only one cent each per trip, it nevertheless figures up to the snug little sum of $6,000,000 per annum, which makes a very comfortable dividend upon a capital of $100,000,000. Such a system would admit of the running of solid trains at very short intervals through the city, and from all points in the suburbs, in every direction, and I venture here and now to predict that within the next 20 years, if not the next 10 years, electrical underground transportation will be brought to such a state of perfection that a passenger entering one of the central stations of New York may be deposited at his home station at any point within a radius of 10 miles in fifteen minutes time, and at a fare of five cents. And this magnificent result is to be the contribution to the convenience and prosperity of the public of the electrical engineer.

Windsor Locks, Conn.—One of the most successful plants of incandescent lighting is the one established last spring at Windsor Locks, Ct. The Electric Light Co. of that town commenced operations at that time with a 500 light dynamo of the Westinghouse alternating current system; since then the capacity of the plant has been increased twice, and to-day the company is able to furnish more than four times the amount of lights of its original capacity. The Westinghouse Electric and Mfg. Company is now engaged with the installation of a 750 light alternating current dynamo.

MR. CORBIN'S PLAN FOR RAPID TRANSIT IN NEW YORK.

A pamphlet has been sent to the Rapid Transit Commissioners, by Mr. Austin Corbin, setting forth his plan for a system of underground electric railways, connecting Battery Park with Brooklyn, Jersey City, and 155th street, and having numerous branches and loops extending east and west throughout the city. The level of the first section, the tunnel under the East River, is fixed at 110 feet beneath the surface. This tunnel, it is announced, will be built in any event, and connections made with the Brooklyn elevated roads, so that even if the whole plan be not accepted, direct and close connection will be obtained between the elevated roads of both cities.

The second section is a continuation of the first, across and beneath Battery Park to a station in Jersey City. The third section provides for a double-track tunnel from the foot of Whitehall street, under Broadway, to the Post Office, with intermediate stations at or near Wall street and Bowling Green. Section 4 is a continuation of this line, from the Post Office, under Broadway to Union Square, where it diverges to the left, continuing under Broadway to and under the Boulevard to One Hundred and Fifty-fifth street; also branching northeasterly from Union Square, to to the line of Third avenue at Eighteenth street, and continuing north under Third avenue to Harlem Bridge; thence northwesterly in close proximity to the Harlem River, until it reaches the line of One Hundred and Fifty-fifth street, forming a complete circuit.

Section 5 is a loop extending from the terminal station at the foot of Whitehall street, northeasterly under Front and Water streets, to the line of Essex street, continuing north beneath Essex street and Avenue A to Tenth street, thence northwest to a connection with the Third avenue line at Twenty-third street. Commencing again at Whitehall street station it continues northwesterly under West street, on a line with the piers and general warehouses to Twelfth street, and thence northerly beneath Tenth avenue to a junction with the Broadway line at Seventy-second street. Section 6 would provide a line to meet the wants developed by the growth of the city in the annexed district. This will be a continuation of the Boulevard line, from One Hundred and Fifty-fifth street on the King's Bridge Road to King's Bridge, and north from Harlem Bridge through Third avenue, having connection with the west line at King's Bridge, forming a circuit around the present Jerome Park.

It is proposed eventually to lay a four-track road on the principal lines of travel, two for high speed and two for way trains The road running parallel with the piers is intended chiefly for the transportation and delivery of freight.

The plan provides arrangements for elevators and underground stations. The elevators at the terminals of the proposed East River tunnel are to have a capacity of 340 passengers per minute. Mr. Corbin states that borings made with a diamond drill at intervals of 500 feet across both rivers, and at numerous points in the city, show a rock formation throughout, with the exception of 2,410 feet in the North River, and possibly a narrow crevasse at Canal street. Over $30,000 has been expended in making these tests.

The cost of a tunnel wide enough for two tracks is estimated at $1,250,000 per mile exclusive of terminals.

The plan is endorsed by gentlemen of great national prominence.

Letters to the Editor.

A PROBLEM IN PHOTOMETRY.

Can any of the readers of The Electrical Engineer give answers to the following problems:

1. In a photometer, suppose the source of light used as a standard to be a large flame with a thin screen in front of it, having a hole in it so as to allow only a part of the flame to shine through it (like in a Methven screen). Query, from where should one begin to measure the distance, from the screen or from the flame?

2. Suppose the screen has considerable thickness, or, to exaggerate, suppose a blackened tube be inserted into the hole in the screen, from where should distance be measured in that case?

3. Suppose, in place of the screen, a parabolic reflector be placed behind the light so as to give a perfectly parallel beam of light, as, for instance, in the Mangin reflectors used in search lights, only supposing the beam to be perfectly parallel; what point should then be taken as the source?

A. T.

Scottdale, Pa.—At a meeting of the stockholders of the Scottdale Electric Light, Heat and Power Company, held Jan. 14th, the following officers were elected for the ensuing year, viz.: Directors, B. F. Overholt, A. S. Loucks, J. W. Ruth, S. C. Stevenson, J. M. McNeil, A. C. Overholt, D. G. Morrow; treasurer, Jacob S. Loucks.

European Correspondence.

LONDON.

Destruction of a Central Station.—Village Lighting.—Death of Prof. Lant Carpenter.—A Committee on Electrical Standards.—Paris and London Telephones.—New Underground Railway.—Electric Railway between Vienna and Buda Pest.

THE news has arrived in England of the total destruction by fire of the Australasian company's central station at Melbourne, causing great inconvenience to the many consumers who were dependent on the station for light.

What may now be considered our propensities for lighting small villages by electricity, is again manifest in a small Welsh village named Abercanaid.

Professor Lant Carpenter committed suicide at his home on Tuesday last. It is said that the deceased gentleman suffered a good deal lately from a mental affection and was under the care of an attendant at the time of his death. A general weak state of health induced him to make a voyage to New Zealand, but when he arrived he became worse, and returned to England at once. Professor Carpenter, who was born in 1841, was the eldest son of the late Dr. W. B. Carpenter, F. R. S. He was educated at the University College School, and took bachelor's degrees in Art and Science at the London University.

The president of the Board of Trade has appointed a committee to consider whether any, and if so, what steps should be taken for the provision of electrical standards. The following is a list of the committee: Lord Rayleigh, F. R. S., and Mr. R. T. Glazebrook, F. R. S., representing the British Association; Dr. J. Hopkinson, F. R. S., and Prof. W. E. Ayrton, F. R. S., representing the Institution of Electrical Engineers; Mr. E. Graves and Mr. W. H. Preece, F. R. S., representing the General Post Office, and representatives of the Board of Trade, including Major Cardew. The first meeting will be held on the 15th of January.

The work in connection with the running of wires for the London and Paris telephone on the English side of the channel has been advanced as far as Ashford, and twenty-five miles of wire will complete the land wires on this side of the channel. The work is done by a corps of men from the Telegraph Department of the Royal Engineers, who number altogether about sixty, and work in gangs at various points on the route. There are four wires, two being return, so that two persons will be able to speak at the same time either at the Paris Bourse or the Royal Exchange, London, where the instruments are to be fixed. The line is expected to be open for use by the end of January, but the cable between the two coasts has yet to be laid. Experiments with the existing telegraph wires showed that the greatest difficulty to be overcome was that of induction. The special wires made of copper are erected crosswise to counteract such effects.

In the last session of Parliament a bill was promoted to acquire powers to construct an underground railway in the district of South Kensington and Underground. This was afterwards withdrawn. A new bill has been prepared in which power is sought to make a subway of a little over a mile and three-quarters in length, in which trains will be run propelled by electricity. A very powerful directorate has been formed, and it is proposed to raise a capital of about £300,000. Of course nothing can be done until the matter has been considered by a Select Committee of the House of Commons.

I mentioned in a previous letter that a scheme was on foot for the construction of an electric railway between Vienna and Buda Pest. I am able to give a few more particulars concerning this project. It is nothing less than the construction of an electric railway traversing a distance of 250 kilometres, for which purpose it is intended to erect six electric generating stations, each controlling an area of 20 kilometres in each direction. It is proposed to maintain the express trains at a speed of 80 or 90 miles an hour, and to charge a fare of three florins for the whole distance. Dr. Julius Kepes has applied for the concession, but the Ministry are by no means as enthusiastic as Dr. Kepes, and they refuse even to enter into the details of the concern until 200,000 florins have been deposited. This, however, is not forthcoming, and probably matters may come to a standstill for the want of funds. It is estimated that fifty million florins are required before the work can be undertaken. It is highly improbable that the money will be subscribed locally as the inhabitants are doubtful of a successful issue.

H. S.

LONDON, Jan. 1, 1891.

COLUMBUS, O.—The Edison Electric Light Co. has elected the following officers: President, Adolph Theobald; vice-president, John Seibert; directors, Charles H. Lindenberg, Adolph Theobald, Emil Kiesewetter, John Seibert, Jacob Bleile, C. T. Pfaff, Joseph F. Martin, F. E. Drake, Louis Seibert.

Home Correspondence.

SAN FRANCISCO.

James Gamble as an Electric Railroader.—President John I. Sabin of the Board of Education.—California Electric Light Stock.—Underground Wires.—Wire Tappers Caught.

I MET James Gamble a few days since. One would expect to find in him a gray bearded patriarch, since his name is inseparably associated with pioneer days of California, but imagine a tall, straight, active, vigorous man of about 50, with beard of the "sable silvered" hue, and you have him as I saw him. He has built, and is operating an electric road from Oakland to Berkeley University, a distance of six miles, and is so enthusiastic that he is now organizing a company to run an electric road from Oakland around San Francisco Bay to San Francisco; taking in Newark, San José, Santa Clara, Redwood City and San Mateo, in all about eighty miles.

As it is proposed to run close to the water's edge all the way, a nicer excursion trip could not be taken and such an enterprise would become very popular. His system is the Edison overhead, and he will not listen to the claims of any other.

We have at last secured a police alarm telegraph and patrol wagon and all are working very satisfactorily. What developments we may expect since John I. Sabin has become president of the Board of Education, is mere conjecture, but as wonders will never cease, an automatic school-marm or a phonographic principal is the least we can expect.

The California Electric Light stock has advanced three dollars per share within the past few days, and is strong in spite of the general financial depression.

The first effort at placing the wires underground through the city was begun some weeks ago by the Telephone, and Western Union Companies, but the work was as suddenly stopped as it unexpectedly began.

J. W. Nagle and William Fallon, two victims of pool rooms, were led not long since into a scheme of reprisal by a discharged operator of the Western Union named Giles. He demonstrated the feasibility of "tapping" the pool room wires and had made a double metallic switch whereby they could receive from the main office, then by aid of an auxiliary battery, resend the dispatches to the pool rooms after detaining the dispatches long enough to give Fallon time to operate in the pool rooms.

Giles, when everything was prepared, informed Mr. Jaynes, of the Western Union, and by his advice, pretended to work in harmony with his confederates. For this he was reinstated in the Western Union and Fallon and Nagle will wear the stripes of convicts for a few years.

SAN FRANCISCO, Jan. 1, 1891.

BOSTON.

The New England Lunch Club.—A Tribute to Col. Ransom.—West End Railway Figures.—New Thomson-Houston Power Generators.

THE New England Lunch Club is the name of a new club formed in Boston for the purpose of providing a first-class restaurant for business men in the vicinity of the Hathaway building and New England building. As these buildings are occupied to a very large extent by electrical enterprises, the Thomson-Houston Company occupying part of both buildings, the members are largely composed of electrical men, so that it is really a down-town electrical club. The initiation fee is ten dollars, and a 50 cent table d'hote is provided, though one can eat a là carte if desired. All interested in electricity, with offices in the vicinity, would do well to become members, as the rooms are pleasantly situated on the top floor of the New England building, and one is sure to meet congenial spirits while lunching.

The January meeting of the Boston Fire Underwriters' Association was held at Young's Hotel, last week, on which occasion a complimentary dinner was given to Col. C. M. Ransom, a gentleman well known to all the electrical fraternity, as lately connected with our contemporary, *Modern Light and Heat*, and now publisher of the *Standard*. The menu provided contained, on the first page, an excellent photogravure portrait of Col. Ransom.

The railroad commissioners gave a hearing this week on the petition of the West End Street Railway Company, for permission to issue $4,500,000 additional stock. A statement was presented showing how the money had been spent derived from the last increase of stock.

The items in this statement were as follows:

Track construction	$ 138,833	97
Difference in value of new tracks over old	418,808	25
Cars and motors	1,308,175	64
Equipment	64,064	45
Electric construction	1,890,380	56
Additions since Sept. 30, 1890	321,141	18
Decrease real estate and horses	136,938	71
Total to Nov. 30, 1890	$3,998,865	34

The statement in addition showed that there is $2,000,000 of stock yet to be issued, but that the increase in property, for which there is a floating debt, is such that if this amount were issued and the floating debt taken up there would be but $128,310.43 unexpended.

The new construction, for which new capital is required, is as follows:

Central power station	$1,200,000 00
East Cambridge power station	650,000 00
Line construction and equipment	500,000 00
Track reconstruction	500,000 00
New car houses	250,000 00
Electric cars	2,400,000 00
Total	$5,500,000 00

The balance sheet of the company, also submitted to the comsioners, is of date of Nov. 30, 1890, and shows:

ASSETS.	
Total fixed property account	$15,805,689 00
Other assets	1,435,571 00
Total	$17,241,261 00

LIABILITIES.	
Capital stock	$9,900,000 00
Coupon bonds	8,250,000 00
Mortgage notes	784,000 00
Floating debt (notes payable, $2,095,748)	2,952,530 00
Total	$16,886,530 00
Surplus	354,730 00

* The hearing was adjourned to February 23d.

The West End Street Railway Company have awarded the contract for the large generators for the new power house to the Thomson-Houston Electric Company. The order at present is for 17 of these generators, but 34 will be required in all. Each generator is to be capable of giving out 360,000 watts, having a maximum voltage of 600 volts, and capable of giving 600 amperes of current. The generators will be built on specifications drawn up by the West End Company, and will be of special design, of the multipolar type, with Gramme armatures. They will measure about 15′ 4″ long by 8′ 6″ wide by about 10 feet high, will run at 400 revolutions per minute, and will not exceed 70,000 pounds in weight. The armature shaft will be 7″ diameter, with bearings 20″ x 5¼″. The commutator will be 30 inches diameter and 15 inches long, having 300 sections. The generators will be compound wound, with six poles and six sets of brushes, and each generator will be provided with complete device for preventing all danger from lightning.

BOSTON, Jan. 23, 1891.

PITTSBURGH.

Chartiers Valley Electric Light and Power Co.—Federal Building Lighting.—Regulating Telephone Rates.—A City Lighting Plant.

THE boroughs of Mansfield and Chartiers, which lie side by side with only the Chartiers Creek intervening, will soon be lighted by electricity. The Chartiers Valley Electric Light and Power Company, a corporation lately organized, has nearly completed its plant. The boilers and dynamos were placed in position a few days ago and the wires are now being strung. About two-thirds of the stock of the company is held by local citizens and the rest by Pittsburghers. Mr. S. A. Duncan, formerly with the Allegheny County Light Company, of Pittsburgh, is now connected with this new company as the general manager.

An electric light plant of 400 one hundred candle-power lamps has just been installed in the Federal Building in this city. The structure is completed, except the inside work of finishing the walls, etc. The darkness, however, prevented any rapid progress of the work and for that reason the incandescent plant had to be resorted to, which is proving a very great success.

A bill was introduced in the State Senate at Harrisburg a few days ago for the regulation of charges for telephone servsce. The bill provides, that not more than $3.00 per month shall be charged for one telephone; that where more than one is in use in an establishment the rates shall not be more than $2.50 for each telephone. It also provides that no payment shall be made for the telephone during any time it is defective or unserviceable. When the Pittsburgh manager of the Central District Telephone Company was asked for his opinion about the proposed bill, he said: "We propose to defend ourselves, and if the legislature passes such a law there will be no telephone system, that is all. We cannot operate telephones for such a price, and as the legislature cannot compel us to do business at a loss we will stop altogether."

Several of the Pittsburgh city officials are very much in favor of the city building its own electric light plant and operating it like the city now operates its water works. The lights for the city streets are now furnished by the East End Electric Light Company and the Allegheny County Light Company at the rate of a hundred dollars per year for each lamp. The officials argue that the city could maintain an electric light plant much cheaper, and that thus a great saving might be accomplished for the city. The matter is to be brought before council in the near future.

PITTSBURGH, Jan. 23, 1891.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the monthly meeting of the Council held on Jan. 20, the following gentlemen were elected to associate membership:

F. C. Bates, Electrical engineer, with Thomson-Houston Electric Co., Lynn, Mass.

Wm. J. A. Bliss, Assistant in Practical Electricity, Johns Hopkins University, Baltimore, Md.

Edward Caldwell, Assistant Editor, *Electrical World*, 167 *Times* Building, New York City.

Charles F. Chandler, Professor of Chemistry, Columbia College, and Prof. of Chemistry and Physics, College of Physicians and Surgeons, N. Y. C.

Gustave J. Fischer, Engineer for Tramway Construction, Public Works Department, Sydney, N. S. W.

Samuel V. Hoffman, Post-graduate Student, Johns Hopkins University, Baltimore, Md.

Arthur B. Levy, assistant engineer, arc light department, Edison General Electic Co., 235 E. 50th St., N. Y. C.

Thos. R. Taltavall, editor, *Electric Age*, *World* building, New York City.

The following gentleman was elected to a life membership:

A. H. Hardy Trott, electrical expert with Thomson-Houston Electric Co., Lynn, Mass.

EXHIBITORS AT THE PROVIDENCE ELECTRIC LIGHT CONVENTION.

THE following are the names of applicants for space at the Providence electric light meeting received up to January 20th:

New York Insulated Wire Co., New York city, insulated wire and cables; Phœnix Glass Co., New York city, electric glass ware, globes, etc.; Washburn & Moen M'f'g Co., Worcester, Mass., samples of wire; Electric Engineering and Supply Co., Syracuse, N. Y., electric lighting and railway supplies; Swartz & Gannett, Providence, R. I., electric appliances, accumulators, phonographs, etc.; the Eddy Electric Motor Co., Windsor, Conn., motors and dynamos; Jewell Belting Co., Hartford, Conn., belting; American Electrical Works, Providence, R. I., insulated wire; Jenney Electric Motor Co., Indianapolis, Ind., motors and switches; Interior Conduit and Insulation Co., New York city, interior and underground conduit; James W. Queen & Co., Philadelphia, Pa., electrical instruments; Drake, Payson & Whittier, Providence, R. I., electric models, motors and specialties; the Okonite Co., New York city, insulated wire, etc.; the E. S. Greeley & Co., New York city, electrical instruments and supplies; *Electrician* Publishing Co., Chicago, Ill., headquarters *Western Electrician*; Alexander, Barney & Chapin, New York city, general electric supplies; H. T. Paiste, Philadelphia, Pa., switches, cut-outs, etc.; The Bryant Electric Co., Bridgeport, Conn., electric supplies; Bernstein Electric Co., Boston, Mass., series lamps and instruments; T. M. Foote Regulator Co., Boston, Mass., speed regulator; the Holtzer-Cabot Electric Co., Boston, Mass., electric light appliances; John Lynch, Washington, D. C., terra cotta conduits; the C. McIntire Co., Newark, N. J., McIntire connectors, etc.; Eureka Tempered Copper Co., North East, Pa., copper brushes, commutators, etc.; Standard Electric Supply Co., Boston, Mass., voltmeters and ammeters; Narragansett Electric Lighting Co., Providence, N. I., display of incandescent lamps, etc.; the Johns-Pratt Co., Hartford, Conn., vulcabeston insulation; Shultz Belting Co., St. Louis, Mo., belting; the Walker Electric Co., New York city, ammeters, voltmeters, etc.; *Electric Power* Publishing Co., New York city, magazine; THE ELECTRICAL ENGINEER, New York city, journal; *Modern Light and Heat*, Boston, Mass., newspaper; Chas. A. Schieren & Co., New York city, belting; Sperry Electric Light Co., Chicago, Ill., arc lamps, etc.; Thomson-Houston Electric Co., Boston, Mass., recording wattmeters; G. G. Stillman, Boston, Mass., Spencer damper regulator.

Wiring will be undertaken by Drake, Payson & Whittier, Washington and Eddy streets, Providence; G. H. Thurston & Co., 59 South Main street; E. M. Carhart, 18 Custom House street; Swartz & Gannett, Swartz Building, and J. F. Hodge, Jr., 146 Westminster street.

Metal and Supply Market.

REDUCTION IN PRICE OF ALUMINUM.

At the annual meeting of the Cowles Aluminum Co. held at Cleveland on Jan. 22, it was decided to reduce the price to $1.25 a pound. This is a reduction of 50 per cent. It was also agreed to increase the capacity of the works at Lockport. When this is done the company claims it will be able to sell pure aluminum cheaper than copper, taking the weight into consideration, copper being nearly four times as heavy.

Reports of Companies.

NATIONAL ELECTRIC MANUFACTURING COMPANY, EAU CLAIRE, WIS.

This company was organized in November, 1888, with a capital of $50,000, which has been increased to $150,000, and its plant has been doubled in size. The officers are: H. H. Hayden, president; Fitch Gilbert, vice-president; R. E. Rust, secretary; George T. Thompson, treasurer, and George B. Shaw, general manager; the other directors being Peter Truax, A. J. Rust, and J. T. Barber. The plant, equipments and machinery, all of which are new and of improved design, are such as would be expected in a corporation of this kind. One hundred and sixty men and women are employed, and from twelve to twenty men are on the road putting in the company's plants. Machinery for two systems of incandescent electric lighting are manufactured—one the ordinary low-pressure system and the other a long-distance transformer system. The annual output will amount to $1,000,000, and is steadily increasing, the orders for machinery running far ahead of the capacity of the factory. The general management has been in the hands of Mr. George B. Shaw, and much of the progress it has made has been due to his efforts. Mr. Shaw is also secretary of the Daniel Shaw Lumber Company, and has served the city as mayor for two terms, and is now serving as Supreme Chancellor of the world in the order of the Knights of Pythias.

ROCKFORD, ILL., ELECTRIC MANUFACTURING CO.

The stockholders of the Rockford Electric Manufacturing Company met Jan. 13, and elected the following directors: C. C. Jones, A. P. Wells, C. M. Haven, G. F. Penfield, J. W. Calkins, F. E. Calkins, W. F. Woodruff. After the stocholders elected the above-named directors the latter held a meeting and elected C. M. Haven president.

INTERNATIONAL OKONITE CO., LIMITED.

The International Okonite Company (Limited), New York and London, has delared a dividend for the six months ended December 31st, 1890, on the capital stock of the company, at the rate of 8 per cent. on the preference and 10 per cent. on the ordinary shares. As stated in our columns last July, this company is the consolidation of the Okonite Company, of America, with Messrs. Shaw & Connelly, of England, both prominent manufacturers of insulated wires and cables for electrical purposes. This liberal dividend shows an immense business done by the International Okonite Company during the first six months of its existence, and while much of this has undoubtedly been acquired in America, the business done abroad has been considerable.

The manufactory at Newton Heath, Manchester, is rapidly nearing completion, and the necessary machinery is nearly all ready for delivery. When this addition to the existing works comes to be fully developed, a noticeable increase in the English business is looked for. The company handle Okonite insulated wires and cables for aerial, underground and submarine electrical purposes, also Candee and Manson wires. These goods will be vigorously pushed abroad, where their popularity is nearly if not quite as great as in this country.

AFFAIRS OF THE WESTINGHOUSE CO.

Discussing the situation at Pittsburgh on January 22, Mr. George Westinghouse said there were full reasons why the checks of contributors should be returned to them. The sum of $500,000 was not enough to relieve his companies without the aid of stockholders and creditors. He exhibited a new circular to stockholders of the Westinghouse Electric Company, which extended the time of subscribing to the preferred stock from Jan. 26 to Jan. 31. He said that 20,500 shares had already been subscribed for, and assurances given which would bring the total amount to 25,000 shares. Some of these subscriptions are conditioned on at least 40,000 shares being taken, and all subscriptions are now taken subject to that condition. The placing of these 40,000 shares will relieve the company of all financial difficulties and place it in a position to push business.

ELECTION OF THE BRUSH ELECTRIC CO.

The annual meeting of Brush Electric Co.'s stockholders was held in the office at Cleveland on January 19. The following officers were elected: President, S. A. Barton; first vice president, Mr. Bartlett; second vice president, C. A. Coffin; treasurer, J. Potter; assistant treasurer, J. F. Hughes; secretary, S. M. Hamil; assistant secretary, A. B. LeVake; board of directors, S. A. Barton, Mr. Bartlett, J. Potter, Myron T. Herrick, C. A. Coffin, C. L. Pease, W. B. Bolton.

Messrs. Charles F. Brush, George W. Stockly and J. J. Tracy retire from the directory of the company altogether though all three still hold some stock.

The Short Electric Motor Company, in which the Brush Electric Company is a stockholder, also held its annual election of officers, re-electing Mr. Short president and Mr. Potter vice president.

The board of directors of the Brush company met, organized and adjourned to an early day when the policy of the company under the new regime will be formulated.

The same night Mr. Charles F. Brush entertained the party from Boston and some of the Cleveland members of the company, at dinner. Twelve sat down to the table.

STOCKS AND BONDS.

SHERMAN, TEX.—The College Park Electric Belt Line, Sherman, was sold to W. M. Scott on the 6th for $10,000 at trustee's sale under the first mortgage to satisfy two claims aggregating $17,000, held by the College Park Co., who had advanced funds to the Belt Line people. Late the same evening the line was shut down until amicable agreement could be had between the purchaser and the Sprague Co., who hold a second mortgage to secure $21,000 due on the electrical equipment.

LA SALLE, ILL.—A transfer of half the stock in the La Salle electric street railway took place the other day, the Merrifields purchasing the interest of E. S. Enyart, W. H. Stead and W. C. Riale. This stock sold for 120 and the purchase price is said to be in the neighborhood of $50,000. With the transfer of his interest in the road, Mr. Enyart has tendered his resignation as superintendent. It is stated that L. B. Merrifield will be the new manager of the road.

NEWARK, O., is to issue bonds for $49,000 for an electric light plant.

DIVIDENDS.

THE MATHER ELECTRIC Co. has declared a quarterly dividend of 1 per cent., and it is said that the year's business has been very encouraging.

WILMINGTON, DEL.—The Electric Light Co. has declared a semi-annual dividend of 3 per cent.

ELECTIONS.

SANDY HILL, N. Y.—The following have been elected directors of the Sandy Hill Electric Light and Power Company (limited): John H. Derby, Grenville M. Ingalsbe, Marcus C. Allen, J. Edward Howland, Sylvanus H. Kenyon, W. B. Baldwin, Seymour Taylor, Charles T. Beach, and John T. Cunningham. The following officers were elected: President, Marcus C. Allen; vice-president, John H. Derby; secretary, Grenville M. Ingalsbe; treasurer, Charles T. Beach.

KANSAS CITY, MO.—The Kansas City Electric Light Co. has elected the following board of directors: W. B. Grimes, J. S. Chick, J. H. North, F. K. Hoover, W. B. Grimes, Jr., James Scammon, E. R. Weeks, F. N. Chick and O. H. Dean. The Edison Electric Light Co. has elected the following directors: W. B. Grimes, J. S. Chick, J. H. North, F. K. Hoover, W. B. Grimes, Jr., W. P. Hix, E. R. Weeks, F. N. Chick and O. H. Dean.

BINGHAMTON, N. Y.—At the annual meeting of the stockholders of the Thomson-Houston Co., the following directors were elected: John Marsh, Frank Gould, H. E. Bundy, J. E. Shapley, Frank A. Miller and M. L. Keyes.

GRAND RAPIDS, MICH.—The Edison Electric Light Co. has elected the following officers and directors: President, Daniel McCoy; vice-president, C. P. Gilbert, Detroit; secretary, Thomas Bechtel; treasurer, Daniel McCoy. Directors, Messrs. C. M. Ayre, J. M. Barnett, John A. Covode, W. R. Shelby, Daniel McCoy, C. H. Gilbert, of Detroit, E. W. Voigt, Detroit, J. R. Markle, Detroit, and J. H. Beggs, Chicago. The report of the company shows a very satisfactory standing. It now has in the city 7,000 incandescent lights, 149 arc lights, and 75 h. p. motors, and with the contemplated addition to the company's plant the facilities will be greatly increased.

MANCHESTER, N. H.—A vote of the Manchester Electric Light Co. taken for directors shows the following result: Frank Dowst, J. W. Hildreth, H. E. Parker, J. B. Varick, William L. Elkins, Jr., J. C. Moore, J. A. Weston, A. Elliott and George F. Lincoln.

LEBANON, PA.—The new officers for this year of the Lebanon and Annville Electric Railway Co. are: President, A. Reinoehl; directors, L. Nutting, S. Brightbill, L. E. Weimer, J. M. Shenk, H. H. Kreider, E. H. Brooks, H. H. Light, W. L. Kreider and R. Mitchell; treasurer, J. H. Hoffer, and secretary, R. Mitchell.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JAN. 20, 1891.

Accumulators:—

Electrode for Secondary Batteries, F. Bain, 444,969. Filed Oct. 17, 1890.

The electrode comprises an envelope of perforated metal containing active material and a porous conducting material, such as carbon.

Clocks:—

Independent Electric Clock, E. Lefebvre, 445,023. Filed Oct. 6, 1890.

Relates to the class of clocks in which electrical energy replaces the usual weight or main-spring: combines electrical energy and the force of gravity.

Clock-Winding Mechanism, W. N. Packer and W. W. Bradley, 445,073. Filed May 5, 1890.

Electro-magnetic self-winding apparatus for clocks driven by weights.

Conductors, Conduits and Insulators:—

Insulator, C. Elkins, 444,879. Filed Apr. 22, 1890.

An insulator and supporting arm adapted to allow a free movement either of the wire through the insulator or the insulator on the wire. A rectangular frame, in two parts, has an insulating anti-friction roller on each of its four sides, and is suspended by a jointed arm.

Insulator, W. Vogler, 445,008. Filed May 23, 1890.

Especially adapted for use upon overhead conductors of electric railways. Consists of an inner body of high insulating capacity and an outer body of high refractory nature to protect the inner body.

Machine for Covering Wire, G. Lispenard, 445,120. Filed Oct. 31, 1889.

Claim 1 follows:

The combination, substantially as hereinbefore set forth, of a main frame, a revolving bobbin-holder having a vertical axis and constructed to support a bobbin or coil of covering material concentrically therewith, devices for feeding a wire or core centrally through the bobbin-holder and through the bobbin, a holder for reserve bobbins above the bobbin-holder, and means for rotating the bobbin-holder and actuating the wire-feeding devices.

Dynamos and Motors:—

Regulating Apparatus for Electric Motors, M. J. Wightman, 444,900. Filed Sept. 19, 1890.

Relates to the apparatus shown in the same inventor's patent No. 435,958, Sept. 9, 1890. The present invention consists in a switch by which a single operating lever is used to make all the connections requisite for coupling two or more motors, driving the same machinery, in various ways, as in series or multiple arc.

Alternating-Current Motor, C. O. C. Billberg and P. A. N. Winand, 444,934. Filed June 10, 1890.

Claim 1 follows:

An alternating-current motor having an armature in the form of a laminated Faraday disc or cylinder and electro-magnets to act thereon, having one or more primary and one or more secondary windings, the armature being connected in the secondary circuit.

Alternating-Current Dynamo, H. Lemp and L. M. Schmidt, 444,939. Filed Sept. 8, 1890.

Designed for use where large or sudden changes of load occur; especially applicable to electric welding. The invention consists in the combination with the armature of a work circuit fed from the armature, a field magnet circuit having a commutator for locally rectifying the alternating currents, but in series with the work, and a branch around the work through which the alternating currents pass in the initial excitation of the machine to the commutator for the field magnet circuit.

Electric-Motor Reciprocating Engine, C. J. Van Depoele, 445,102. Filed April 18, 1890.

Claim 2 follows:

A reciprocating engine comprising an electric motor having a stationary part or field-magnet, a rotating part or armature revoluble therein, a tool-stock adapted to be reciprocated through said rotating part or armature, the latter being sleeved thereupon, a motor-spring acting upon and imparting the power-stroke to the tool-stock, and means carried by said rotating part or armature for alternately compressing and releasing the motor-spring.

Ignition:—

Automatic Electric Igniting Device, T. W. Lane, 444,896. Filed June 13, 1889.

For turning on gas and automatically lighting it. The object of the improvement is to so construct and adjust the pawl-carrying bar with the armature, that the bar may be capable of more extended movement than the armature, thus effecting a sufficient movement of the gas-cock without an inconveniently large excursion of the armature.

Lamps and Appurtenances:—

Combined Electric Motor and Lamp-Socket, R. H. Beach, 444,807. Filed Aug. 21. 1890.

A small fan motor provided with an extension adapting it to be inserted in a lamp-socket in place of the lamp when desired.

Electric-Arc Lamp, E. Thomson, 444,925. Filed Nov. 22, 1884.

Instead of relying for regulation upon the differential action of a direct and a shunt electro-magnet, as in usual practice, the organization is such that the direct-circuit magnet and the derived-circuit magnet are in a measure independent. The derived-circuit magnet is opposed by a spring, and the force in play in adjusting the carbons is sometimes that of the direct-circuit magnet alone, and at other times it is the surplus of force which the derived-circuit magnet exerts over the restraining force of its opposing spring.

Incandescent Electric Lamp, E. Thomson, 444,920. Filed Aug. 4, 1890.

Applicable to lamps designed for use in series with one another or with arc lamps on circuits carrying high potential currents. Relates to the provision of means for automatically completing the circuit in case of the rupture of the filament. Consists broadly in the application to lamps having an automatic cut-out device of a supplemental cut-out adapted to be operated by the disruptive action of the current on the failure of the arc to form on sudden interruption of the current in the lamp by breakage of the filament.

Electric-Arc Lamp, W. H. Elkins, 444,977. Filed July 26, 1890.

A combination of two distinct lamps with a spring switch composed of two blocks and a spring actuated movable portion controlled by a magnet which is part of a shunt circuit; like terminals of the lamps are connected with the switch block and the other terminals with the main circuit; the shunt circuit is broken when the first lamp is cut out.

Multiplex-Arc Lamp, W. H. Elkins, 445,136. Filed Oct. 25, 1890.

Amplification of No. 444,977 above.

Measurement:

System of Distributing and Metering Electric Energy, E. Thomson, 444,930. Filed Sept. 22, 1890.

Relates to distribution for series or constant current lines. And the object is to provide for measuring the amount of energy used at different points on such lines. Each lamp or set of lamps, or other translating devices, is placed in a loop of the main circuit, and across each loop a measuring device is connected in such a manner as to obtain a registry, not of the current flowing on the line, but of the difference of potential at the ends of the loop. The voltage of the lamps being known, account may thus be taken of the number of lamps used in each loop or of the aggregate period of use, by making virtually a registry of the volt hours.

Electric Meter, E. Thomson, 444,931. Filed Sept. 22, 1890.

For measuring the consumption of energy in translating devices operated upon constant-current or series circuits. Consists in combining with the translating devices an electric motor of any suitable kind having the usual field magnet and armature, one element of which motor is traversed by a current varying according to the differences of potential at the terminals of the loop containing the translating devices, while the other element has an excitation substantially constant in amount, and a registering device for registering the movements of the movable element of the motor.

Electric Indicator, C. Wirt, 444,966. Filed Jan. 6, 1890.

An indicator or meter applicable either as a voltmeter or as an ammeter by varying the character of the conductor or coil.

Claim 1 follows:

The combination of a conductor, an armature suspended in proximity thereto, and an indicator operated by such armature, said armature free to move only so that each point of its effective surface traverses a path equidistant from that of the current at the effective portion of the conductor.

Metal Working:

Portable Electric Welding Apparatus. E. E. Ries, 444,855. Filed Aug. 2, 1890.

A welding apparatus or outfit including a generator which can be transported from place to place; especially adapted for use along a line on which at predetermined intervals electric welding is required for the production of continuous structures, as rails or conductors for electric railways, or pipe lines.

Electric Blank-Heater for Forging-Machines, G. D. Burton, and E. E. Angell, 444,914. Filed Oct. 7, 1890.

The electrodes and their co-operative parts are adjustable to suit blanks of various lengths for forgings of different sizes; the electrodes are adapted automatically to grasp and release the blanks, and are under the control of the operator for determining the heating periods.

Claim follows:

In an electric blank-heater, the combination of two electrodes adapted for holding a blank to be heated, and vertical and horizontal oscillators for imparting vertical and horizontal oscillation to said electrodes.

Method of Electric Welding, E. Thomson, 444,926. Filed May 15, 1888.

Applicable particularly to the operations of electric welding set out in the same inventor's patents Nos. 347,140 and 347,141. Designed to facilitate the operations and to keep control of the temperature of the objects operated upon. Consists broadly in first applying a current of great heating effect, accumulating heat in the object under such current until the required temperature is nearly attained, and then diminishing the current, but not so much as to prevent the rise of temperature to the proper point.

Method of Electric Welding, E. Thomson, 444,927. Filed May 15, 1888.

Relates to the processes of metal working set forth in the same inventor's patents Nos. 347,140, 347,141 and 347,142 and in British patent No. 10, 241 of 1886. Similar in part to No. 444,926, above; but adds provision for gradually diminishing the heating current from the start.

Method of Electric Welding, E. Thomson, 444,928. Filed June 14, 1890.

Relates particularly to the process of joining strips, sheets, plates or bars of metal where a weld of considerable length is required, as joining plates at their edges, joining strips or ribs to plates for strengthening them, forming longitudinal joints in the manufacture of metal pipes, &c. Consists essentially in feeding the work in the longitudinal direction of the joint through suitable pressure devices during the passage of the heating current.

Method of Electric Welding, E. Thomson, 444,946. Filed May 15, 1888.

Consist, essentially, in maintaining at the points at which the current enters and leaves the work, an approximately constant difference of potential, so as to effect a gradual heating af the work automatically through the gradual increase of resistance of the work due to its increasing temperature.

Miscellaneous:—

Electric Gate, H. Gillette, 444,825. Filed Oct. 3, 1890.

The gate posts are provided with a guard-bar mechanically connected to two electric motors; a generator, circuit closers and automatic circuit breakers are provided.

Electrical Exercising Machine, J. B. Gardiner, 444,881. Filed June 2, 1890.

A combination of mechanical and magneto-electric apparatus whereby electric currents are generated through the energy expended by the operator and transmitted through his person during his exercise.

Combined Cut-Out and Lightning-Arrester, A. T. Aldrich, 444,892. Filed June 20, 1890.

Particularly applicable for telephone lines. Consists of details in the construction and mode of supporting the fuse-wire holders and in combining with the holders and fuse-wires suitable connections with one or more ground wires.

Electric Switch, B. B. Keyes, 445,146. Filed Aug. 16, 1890.

A circuit breaker and closer of the quick acting or "snap" type.

Railways and Appliances:—

Railway-Signal, N. B. Creigier, 444,819. Filed Oct. 25, 1887.

The principal object is a train-signalling system in which a signal sent from any car of a train to the engine or from the engine will be repeated automatically in every car of the train. It is a closed circuit system.

Claim 1 follows:

In a signal system for railway trains, the combination of a closed circuit for the electrical current and mechanical generators, signalling devices, and switches in and operating on said closed circuit.

Snow-Sweeper, I. F. Baker and R. Booth, 444,871. Filed Jan. 29, 1890.

Relates to rotary sweepers, and is especially applicable to snow-sweepers for street railways in which the cars are propelled by self-carried electric motors supplied by a current from an outside source through a line of conductors.

Trolley for Electric Railways, H. H. Blades, 444,893. Filed Aug. 11, 1890.

Claim 1 follows:

In an overhead trolley for electric railways, the combination, with the trolley-rod pivoted at its base to the supporting-plate, of two coil-springs having their lower ends rigidly engaged to the said supporting-plate and their upper ends engaged to the rod above its pivoted end.

Mounting for Electric-Car Motors, E. W. Rice, Jr., 444,922. Filed Aug. 15, 1889.

The frame consists of side pieces and a uniting cross-piece; the motor has the field-magnet supported at its yoke and on the side-pieces of the frame and at its pole ends by extensions from the poles resting upon the cross-piece of the frame.

Electric Motor Truck, R. P. Faries, 445,051. Filed Sept. 23, 1890.

Friction wheels or rolls are yieldingly held in contact with the truck wheels and flexibly connected with and arranged to be driven by the armature shaft.

Trolley-Wire Clamp or Support, W. Vogler, 445,103. Filed April 8, 1890.

Consists of two members grooved at their inner sides to enclose the trolley-wire over more than half of its circumference; the members are clamped together and are provided with a locking device to retain the ends of the conducting wire.

Electric Signal for Railroads, E. C. Wiley, 445,106. Filed May 15, 1890.

Consists, generally, of two line wires parallel to the track having branches leading to points adjacent to one of the rails, together with devices actuated by the car wheel and circuit-closing brush on the locomotive tender; the signalling devices thus operated being intended to sound an alarm upon locomotives approaching each other on the same track.

Trolley-Wire Support for Electric Railways, J. S. Hughes, 445,142. Filed April 19, 1890.

Consists essentially in an arch of tubular cross section, resting upon posts at the sides of the streets, in place of the ordinary span wire.

Electric-Railway Car, R. M. Hunter, 445,144. Filed Oct. 4, 1886.

The electric motor, carried by the car body, is located below the floor and independent of the truck; the frame for the gearing and motor shaft is sleeved on the axle independent of the car body.

College Notes.

COOPER UNION, N. Y. CITY.

A free class in electrical measurements for advanced students has been established at the Cooper Union. The lectures are given by Prof. Robert Spice every Friday evening at half-past eight o'clock.

HARVARD.

Professor Hall and the men in Physics paid a visit to the stations of the Boston and of the Edison Companies, a short time ago, and spent a very pleasant evening in inspecting the machinery. It is an agreeable feature of electric light stations that no matter how late you come, the station is still open. Whether you call at eight o'clock or twelve, you receive the same warm greeting.

Two very interesting lectures were given last month before the members of the Electric Club. The first was upon Self-Induction, by Mr. Sabin, of the Jefferson Laboratory; the second upon Magnetism, by Dr. Wilson, also of the Jefferson Laboratory, who has done much valuable work in this subject.

There are at present seven Harvard men with the Thomson-Houston Company. They are graduates of the college, or of the Lawrence Scientific School. Their names are L. K. Perot, L.S.S.; E. A. Bailey, L.S.S.; E. H. Lewis, L.S.S.; J. C. Barr, '90; P. M. Reynolds, '90; R. G. Fessenden, '90; and F. H. Kennard, '88. Of these Mr. Kennard is at the Boston office, Messrs. Barr, Fessenden and Reynolds are out on the road from the factory, and the rest are at Lynn. Mr. Perot is at work on the characteristic curves of the motor-type dynamo, Mr. Bailey is testing the magnetic qualities of various kinds of iron, and Mr. Lewis is engaged upon some ballistic work, of which Mr. Perot is soon to take charge.

A series of lectures by Mr. B. I. Gilman, on the "Psychology of Music," opened last week in Sever Hall. The earlier lecture in this course will deal with pitch, timbre and other properties of sound. Many of the Physics men were present, but whether to refresh their knowledge of acoustics or to smile at the fair scientiste from the "Annex" I can't say. The lecturer sounded notes from 16 vibrations a second up to 25,000. The audience failed to hear anything below 32 or above 22,000.

I understand that the lectures in Physics for freshmen are to be given in the evening instead of the morning, this year. They will begin on Wednesdays.

The Electric Club has adjourned for the mid-year examinations. Preparations are being made for the course of public lectures. Probably six or eight will be given.

At the last meeting, Mr. Smith, the secretary, resigned, and Mr. G. S. Curtis, '92, was elected to his place. Mr. Hoppin, '93, was elected to fill Mr. Curtis' place on the Executive Committee.

G. T. P.

Legal Notes.

WESTERN UNION'S TAXES IN MASSACHUSETTS.

H. C. Bliss, assistant attorney general for Massachusetts, at Washington, began, on Jan. 19, the argument for the Commonwealth in the case against the Western Union Telegraph Company for taxes. The defence of the Western Union Company appears to be that it is operating under a national charter, the Federal Act of 1866, which exempts it from local taxation. Mr. Bliss presented in the case a letter of Norvin Green, president of the Western Union, to Postmaster-General Wanamaker in the postal telegraph controversy, in which Mr. Green did not seem to attach much importance to the Federal laws of 1866. The hearing will be concluded to-morrow.

DAMAGES FOR AN EXPLOSION.—A QUEER VERDICT.

In Common Pleas Court, No. 1, Philadelphia, President Judge Allison presiding, a verdict has been rendered in favor of Elizabeth McCardle against the Penn Electric Light Company, of New Jersey. The claim was based on the allegation that the husband of Mrs. McCardle was so badly burned by an explosion of gasoline at 908 Sansom street, on November 17, 1887, that he died a short time thereafter; that he was in the employ of the company, and that the explosion was caused by the negligent manner of filling and lighting a gasoline lamp in the building by another, where Mr. McCardle was in the pursuit of his employment. The defence set up that he was not in the employ of the company, and that even if he were, she could not recover because the accident was due to the negligence of a fellow-workman. The jury gave Mrs. McCardle $4,300 damages.

Appointments, Etc.

MR. H. F. WATTS has resigned as superintendent of the Meriden, Conn., electric railway.

MR. T. H. CHRISTIE has been appointed assistant superintendent of the Rochester, N. Y., Electric Railway.

MR. C. L. PEASE, of the Westinghouse Electric Co., has become associated with the management of the Brush Electric Co., of Cleveland.

MR. F. A. SCHEFFLER, of the Westinghouse Electric Co., has joined the forces of the Brush Electric Co. in Cleveland.

MR. F. G. SCHLOSSER, a Cornell University man, was appointed lately superintendent of the electrical department of the Laclede Gas Co. Mr. Schlosser has been connected with the department as superintendent of construction for over a year past.

MR. MORTON EDEN, lately of the Essex Electric Railway Co., Salem, Mass., and formerly with the Brush Corporation, of England, has been called to Cleveland to take a position in the construction department of the Brush Electric Co.

MR. A. G. REYNOLDS, of Toledo, O., has succeeded Mr. J. A. Duggan, as superintendent of the Quincy & Boston Street Railway Co.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of January 24, 1891, from New York, Boston and Washington; Pittsburgh, January 23.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	78⅛	Edison Gen. Elec. Co	94
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Centl. & So. Amer	*145	Consol'd Elec. Lt. Co	...
Mexican	*210	Edison Illu'g Co. N. Y.	70
Com. Cable Co	104	U. S. Elec. Lt. Co	30
Postal Tel. Cable	89	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	43	Ft. Wayne Co	11
" Pref'd	25¼	Am. Bell	203
" Series C	....	Erie	49
" " D	5⅛	New England	51
" Int. Co	....	Mexican	.60 cts
Thomson Welding Co	....	Trop. American	..
Thomson Eu. Welding	58	Edison Phon'gph Doll	1

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	138
Ches. & Pot. Telephone	*63	Eck.&Sold. Home Elec. Ry.	58
Amer. Graphophone	9⅞	Georgetown & Tenallytown	49

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	8⅛

* Ex Dividend.

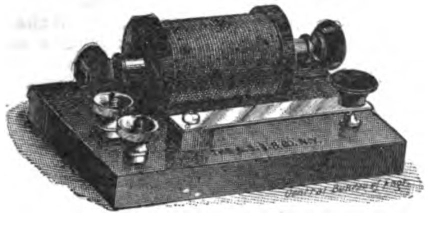
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"If you would move the electrical trade, try the motor of advertising."

THE FREY MAGNETO ELECTRIC BRAKE.

THIS is a convenient little contrivance for checking the swing of the needle or system of a fibre suspension galvanometer, by sending a slight induced current through the coils, the effect of which is to tend to swing the system in a direction opposite to that in which it is moving. The current being slight and capable of being nicely regulated, the deflection can be readily brought to zero. The instrument consists of a coil, the terminals of which are connected with the galvanometer through a contact key. A small bar magnet is pushed or pulled through the coil.



THE FREY MAGNETO ELECTRIC BRAKE.

This apparatus is the invention of Mr. Charles P. Frey, and is being placed on the market by The E. S. Greeley & Company, of New York.

F. & M. DEP'T, HARRISBURG CAR M'F'G CO.

The F. & M. Department of the Harrisburg Car M'f'g Company, as we stated some weeks ago, will soon be reorganized as a separate company. In the meantime they are full of work and could do even more than they are doing at present, were they in a position to go ahead and push harder, as they will be at the consummation of their reorganization. Of course it takes some time to hear from all their creditors and stockholders as to the organization of the new company, but as the F. & M. department has always been a handsomely paying enterprise apart from the Harrisburg Car M'f'g Company, itself, it seems too bad that its works should have been crippled and that it should be carried down with the car manufacturing company, through no fault of its own. However, the cloud is only temporary and will soon blow over, if, indeed, it has not already vanished in thin air.

ELECTRIC STREET CAR GEARING.

The following letter has been received by the New Process Raw Hide Company, of Syracuse, N. Y., and which is explanatory of itself :

SCRANTON, PA., Jan. 9th, 1891.

THE NEW PROCESS RAW HIDE CO., Syracuse, N. Y.

Gentlemen :—In reply to your favor of the 6th inst., would say that I have experimented with most everything in the way of motor pinions and find nothing that works so satisfactorily as pinions of your manufacture.

I am so thoroughly satisfied that the raw hide pinions of your manufacture are the best kind of pinions on the market, that I am equipping all our cars with them and will not look at any other kind.

The first I tried, those without being rivetted, ran 15,490 miles, and were to all appearances good for 1,000 miles more.

Yours very truly,

[Signed] J. H. VANDER VEER,
Gen. Mgr. Scranton Street Railways.

EUREKA TEMPERED COPPER IN ELECTRIC RAILWAY PLANTS.

The following letter is very interesting as throwing a little light on some of the questions of electric street railway work :—

KEY CITY ELECTRIC STREET RAILWAY CO.,
Dubuque, Ia., Dec. 27, 1890.

EUREKA TEMPERED COPPER CO., North East, Pa.

Gentlemen :—I send you by express to-day sample ratchet brake casting for pattern. Supply cog for the one broken out in the pattern.

Please make and ship by express as soon as possible one dozen tempered copper ratchet castings. I will send one of them to the manufacturers of our cars and explain that we broke on an average of one a day of cast iron ratchets and recommend the use of tempered copper for ratchets.

The tempered copper liners made for the John T. Noye Mfg. Co., Buffalo, N. Y., for their engine, which was installed here some months ago, were put in by us a few days ago and are giving perfect satisfaction. Up to this time we were unable to find any liners that would stand the severe service. I will report the matter to the Noye Co. and recommend that copper liners be used on the new engine which they are making for this new company. Possibly it may lead to their being adopted by them generally.

Yours truly, JOS. ANGELL, Sec'y.

ANSONIA BRASS & COPPER CO.

The Ansonia Brass & Copper Co. have issued a very tasteful New Year souvenir. It is bound in celluloid with leather back. The contents are a series of views of their huge brass rolling mills, copper rolling mills, lamp, chandelier and wire insulating factories, wire mills and the Ansonia clock factory in Brooklyn. The pictures are most impressive, and give one an idea of the enormous extent to which the various industries have grown up and ramified during the last few years. On the back cover is an engraving of the handsome headquarters occupied at 19–21 Cliff street, this city.

THE BERLIN IRON BRIDGE CO.

The business of the Berlin Iron Bridge Co., of East Berlin, Conn., has increased so rapidly in the last few years that the stockholders deemed it advisable at the annual meeting on Monday, the 19th. to increase the capital stock from $125,000.00 to $300,000.00. The entire increase has already been subscribed for by the present stockholders.

The additional capital will be used to improve their plant at East Berlin, and the company will immediately put up a new building 80 ft. wide by 600 ft. long and expect to have it equipped with machinery and in running order by the 1st day of July.

During the past few years this company have been compelled to run their works day and night during the greater portion of the time, but with their improved facilities they will be able to do 25 per cent. more work than they have been doing and not run their plant over ten hours per day.

They have shipped during the past year 8,000 tons of iron work consisting of iron bridges, iron buildings, and iron roofs. Their sales amounted to nearly $1,000,000.00 and their work was put up in nearly every state in the Union. The company now have regular established agencies in San Antonio, Texas, Binghamton, N. Y., Buffalo, N. Y., Pittsburgh, Penn., Raleigh, N. C., Dayton Ohio, Enterprise, Miss., and Omaha, Neb.

The prosperity of the company is attested by the greatly increasing demand for their work from all parts of the country, and by the fact that the large increase in the capital stock was fully subscribed for by the present stockholders.

ALUMINUM BRASS & BRONZE CO.

T. L. Fowler, manager New York office, Aluminum Brass & Bronze Co., 53 Chambers street, has been appointed general manager of the above company and transferred with headquarters at Bridgeport. Mr. Frank G. Stone, general sales agent, assumes charge of the New York office in place of Mr. Fowler and will continue to convince all comers that the silicon bronze wire is the best for purpose to which it is adapted.

TUCKER & HALL.

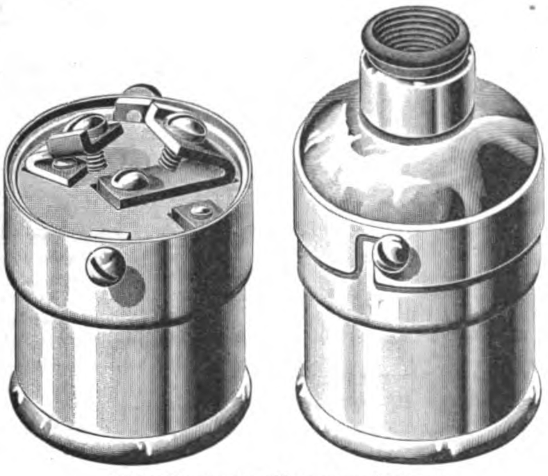
Tucker & Hall, of No. 8 Pulitzer Building, is the name of a new firm of electrical contractors. The men constituting this firm are old practical men, having been connected with electrical construction for some 12 years back. They start in with the very best wishes of a large number of people who happen to know them, and have under way and finished the following contracts : Metropolitan Life Insurance Co., New York ; Central Trust Co., New York ; Union Trust Co., New York ; Pulitzer Building, New *World* Building ; Central R. R. of N. J. Building ; Morgan S. S. Line, 2 piers ; Chas. Horn's Silk Mills, New York ; St. John's College, Fordham, N. Y. ; Smith, Gray & Co., Brooklyn, N. Y. ; McLoughlin Bros., Brooklyn, N. Y.

FILLEY, PARKER & FILLEY, of 296–300 Oakland street, Greenpoint, Brooklyn, E. D., are licensees for Connecticut, New York and New Jersey of the Harvey-Filley Aluminum Plating Co's. process of aluminum and bronze plating. This process gives a most beautiful and lasting finish and will no doubt prove of considerable interest and advantage to the electrical people, such as the plating of instrument cases and work of like nature.

THE "ELECTRIX" KEYLESS SOCKET.

We illustrate in this issue a new keyless socket, the "Electrix," which is just being brought out by the Star Electrix Co., of Philadelphia. This socket is made to fit any lamp and contains nothing in its make up but porcelain and brass. It is easily wired and considered very neat in appearance.

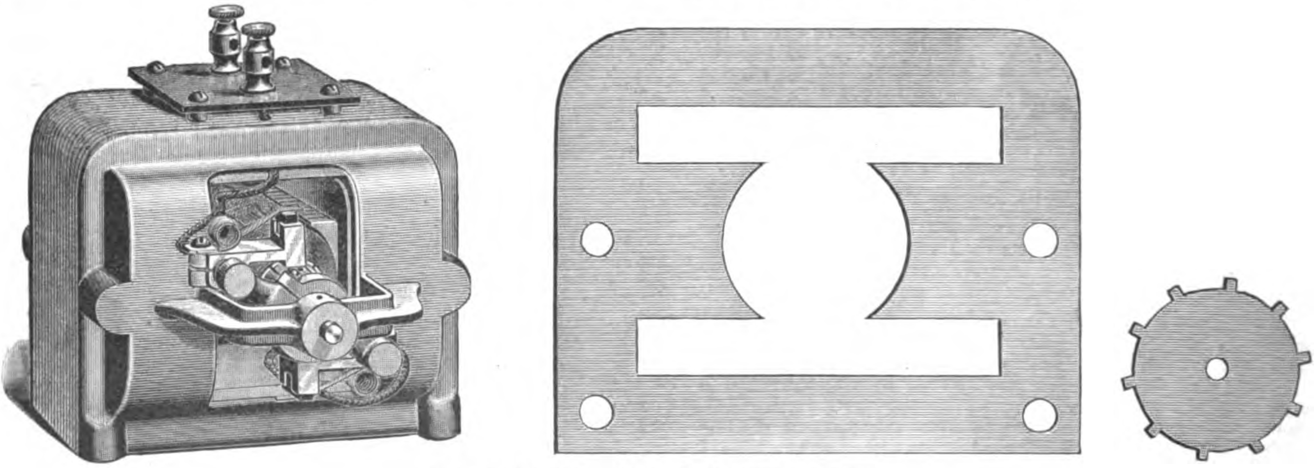
This enterprising firm continue to add new things every few weeks and already have quite a complete line of electric lighting supplies such as 5 amp. and 10 amp. S. P. switches, 25 amp. D. P. switches, key and keyless sockets, insulating joints, gas attachments, ceiling cut-outs and branch and main cut-outs, etc.



THE ELECTRIX KEYLESS SOCKET.

SMALL HIGH CLASS MOTORS.

It has been remarked that it requires greater care and a more profound knowledge of the science of electrical engineering to design and construct a highly efficient motor or dynamo, of, say, one-eighth horse-power than is necessary to design and construct one of ten h. p. or larger. But to meet a demand for an efficient small motor, Mr. Forée Bain, of the Bain Electric Manufacturing Co., 47 and 49 South Jefferson street, Chicago, has designed the machine shown in the engraving, Fig. 1. The field magnets and armature cores of the machine, as shown in Figs. 2 and 3, are stamped of the best soft sheet iron. The sheets of the field magnets, in which there are no joints, are then varnished and held together by a stud in each side, this stud also passing through a cast iron guard on either end. This guard answers as a means for making the motor "iron clad," and it also carries the two bearings. The shaft is made of best Stubbs steel ground true on centres. The armature has a Siemens core with Pacinotti projections, and its winding is Mr. Bain's modification of the Frölich method. The commutator is large and solidly made, and the brushes are made of a patent material resembling carbon. The advantages claimed for this little motor are numerous.



FIGS. 1, 2 AND 3.—NEW BAIN SMALL MOTOR.

As the field coils are placed as near to the armature as possible, all the lines of force of the field coils are concentrated in the core, and there are no radiating magnetic lines of fore, and the machine is "iron clad."

The best mechanical construction has been adopted; the bearings do not require oil or grease, or lubricant of any kind, and as the machine is self-contained, no nuts, bolts or screws can become loosened.

Machines of this type are carried in stock from one-twelfth horse-power to one horse-power, and they are wound for battery work from 2 volts to 25 volts, and also wound for 110 volt current and constant current of from 6½ and 10 amperes.

POPULARITY OF CROCKER-WHEELER MOTORS.

The Crocker-Wheeler Motor Co. are having large orders for their perfected motors. Among the installations recently made are the following: The Union Club, Hotel Normandie, New York Whist Club, The National Bank, Dr. Fuller, Thirteenth street and Fifth avenue; Photogravure Co.; Star Theatre; Metropolitan Tel. & Tel. Co.; Worthington Pump Co.; Malony's saloon, 1 Park Place; Nilson's, Equitable Building; Rogers & Co.; Ellsworth & Co.; Johnstone, 22 John street; Sutton, 466 Third avenue; Glattstein, 450 Broome street; Bergmann, 110 West Twenty-fourth street; Lang, 157 East Forty-second street; Gilbert, Heiland & Beitler. They are also finding extensive sale for their new reversible motors with fire proof regulators, and have sent several of these among a large shipment recently to their London house, The General Electric Co.

THE STANLEY & HALL CATALOGUE.

One of the handsomest trade catalogues of the season is that just issued by the pushing and painstaking firm of Stanley & Hall, the manufacturers of electrical house furnishings, 32 and 34 Frankfort street, this city. Unless a maker of such apparatus is of progressive tendencies his printed matter will soon lose its interest, and his catalogue becomes a mere list of museum antiquities with which the public have but little concern. The example of catalogue-making before us is in its way as thorough a piece of enterprise and originality as the Pulitzer building that stands so near the Stanley-Hall factory.

The book is of 70 quarto pages, handsomely bound in blue, with the lettering on it in a shade of deeper blue, together with a large picture of their "S. H." bell, in a rich red. The typography is excellent, no small type being used at all, while the figures for prices are unusually large and clear—though the largeness does but emphasize the actual smallness of the quotations appended to the various articles. All the apparatus shown is new and fresh and in active demand in the market, and all necessary details are given in regard to it. There is moreover at the end a complete and well arranged index. The firm makes an admirable showing of its products and specialties, and is evidently destined even on its present lines to turn out a fatter volume every year.

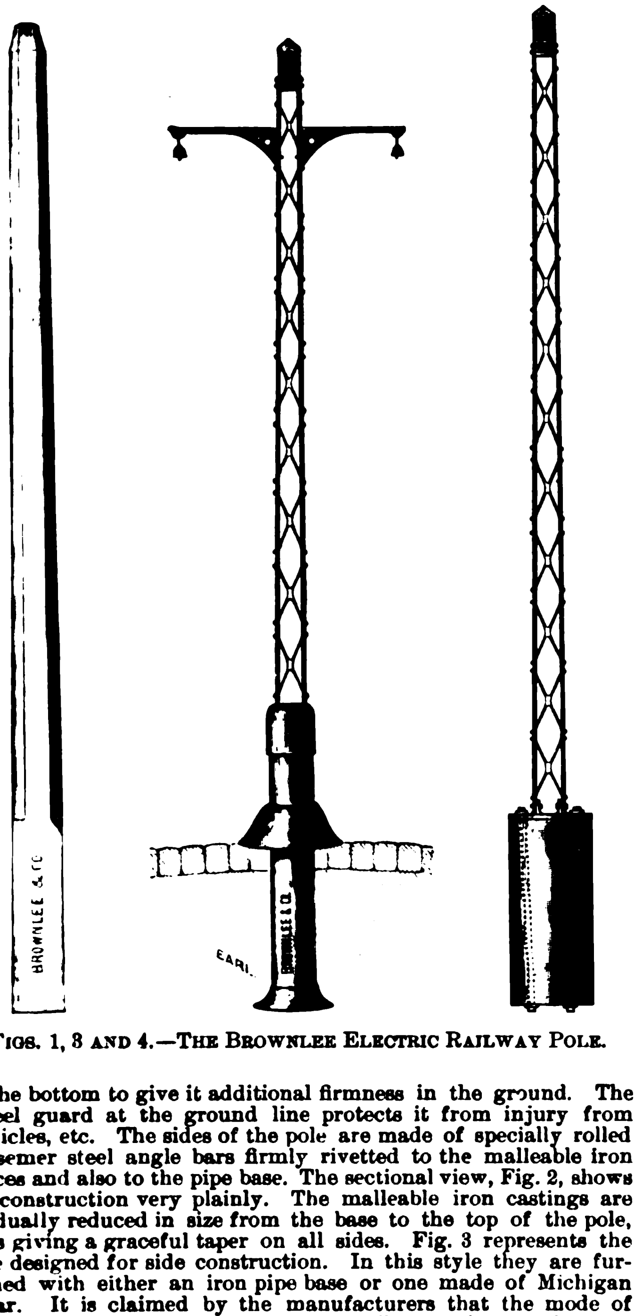
THE CUTTER STREET HOOD.

In many places outdoor incandescent lights are preferable to arc lamps, and with a good reflector and a good protection to the socket they are quite practicable. This accounts for the large sale of Cutter's street hood, which combines a protecting covering for the socket with an enameled reflector. This reflector is shaped so as to distribute the light evenly over a wide area, and is hinged so as to admit of ready access to the socket. This hinge in turn was designed to allow the hood to be shipped in pieces and to be put together without the use of solder or even of a screwdriver. Such points about a street hood seem to count, and Mr. George Cutter is busy making them at his new shop.

BROWNLEE'S ELECTRIC RAILWAY POLES.

Electric street railway work has called forth a demand for light, strong and graceful iron pole to remove as far as possible the objections which are frequently raised against the placing of poles in streets. To meet these requirements Messrs. Brownlee & Co., of Detroit, Mich., have recently brought out the novel types iron pole illustrated in the accompanying engravings.

The pole designed for centre construction is shown in Fig. 1. As will be seen, the base of the pole is made of pipe with a flange at the bottom to give it additional firmness in the ground. The wheel guard at the ground line protects it from injury from vehicles, etc. The sides of the pole are made of specially rolled Bessemer steel angle bars firmly rivetted to the malleable iron braces and also to the pipe base. The sectional view, Fig. 2, shows the construction very plainly. The malleable iron castings are gradually reduced in size from the base to the top of the pole, thus giving a graceful taper on all sides. Fig. 3 represents the pole designed for side construction. In this style they are furnished with either an iron pipe base or one made of Michigan cedar. It is claimed by the manufacturers that the mode of bracing these poles gives the greatest stiffness and strength.



FIGS. 1, 3 AND 4.—THE BROWNLEE ELECTRIC RAILWAY POLE.

Fig. 4 represents an octagonal wood pole which was introduced by Messrs. Brownlee & Co. a little over a year ago, and is now well and favorably known. During the last season they were unable to fill all orders offered, but have now increased their facilities and are now prepared to supply the steadily increasing demand.

ENGLISH, MORSE & CO.

The Kansas City firm of English, Morse & Co. have shipped the past week to Garnett, Kan., a 60 h. p. Ide engine. It will be used in a combined electric light and water works station which the city have contracted for. They have also shipped an additional 50 h. p. steel boiler to the Butte City Gas Light Co., Montana, and have Swift & Co.'s contract for a Barr compound duplex pumping engine of 1,000 gallons capacity per minute. Their Lahman-Kirkwood shaking and dumping grates, American leather link belt, Hill clutch pulleys and couplings are very popular with operators of electric light and railway stations, and trade in their engineering specialties generally is quite good.

SUNBEAM INCANDESCENT LAMP CO.

The above company, of 805 Chamber of Commerce Building, has recently settled in new quarters larger than those heretofore occupied, where with specially designed apparatus and the best known modern equipments they are prepared to take care of their growing trade. Since June last until now they have been unable to fill all the orders that have come to them. This fact, which they regard as a fair indication of the merit of their lamp, has compelled them to carry out their plans for extension of facilities, referred to above.

MR. W. S. CHESLEY.

This gentleman, who has had experience in electric installation work, has recently opened an office at 171 Broadway, this city, where he proposes to do an electrical engineering business, including the installation of plants of all descriptions. In addition Mr. Chesley has undertaken the purchase and sale of all kinds of electrical apparatus, including second-hand electrical goods, such as dynamos, lamps, etc. Mr. Chesley's past experience well qualifies him for this work and as the handling of second-hand goods has thus far been entirely neglected in this vicinity, Mr. Chesley may confidently look for a large and growing trade.

THE WALKER ELECTRIC CO.

The Walker Electric Company, of this city, whose simple and ingenious meter is well known to our readers, have recently enlarged their offices and facilities and are doing a large and increasing trade. Their simple ammeters and voltmeters are meeting with favor in many stations and among those recently supplied are the Mt. Morris Electric Co., and C. & C. Electric Motor Co., of this city, the Elektron Mfg. Co., W. T. Goodnow, of Lebanon, Ky., the Holtzer-Cabot Co., of Boston, the Pacific Electrical Storage Co., of San Francisco, and a large number of others. The Walker electric meter, which gives a continuous photographic record of the consumption of current, is meeting with success as it overcomes the difficulties heretofore experienced in apparatus of this kind.

A DESIRABLE FACTORY.

Our electrical friends who are casting about for a suitable place for manufacturing their specialties should not fail to notice the illustrated advertisement of a machine shop in another column. We know the parties advertising, and can vouch for their entire respectability and responsibility for their statements. We are assured that it is an uncommon opportunity on account of the moderate rate of wages prevailing in the vicinity, low rent and general eligibility of location.

EDISON-LALANDE BATTERIES.

The Edison Manufacturing Co., of Orange, N. J., has issued a very handsome quarto catalogue and illustrated price list relative to its Edison-Lalande batteries. It has an unusually good introduction in the shape of a discussion of primary batteries, the points of superiority claimed for the Edison-Lalande being enforced by a number of diagrams and curves of tests. There are also a large number of fac-similes of testimonials from users of the battery, and some data as to specific employments for which it is well adapted. The second section consists of instructions as to setting up, with details as to sizes, prices, capacity, hours of running, etc. It is in fact the best battery pamphlet issued at the present time. Every point or argument that could be made in behalf of the battery is here set down strongly and clearly, and the whole is presented in most interesting and attractive form.

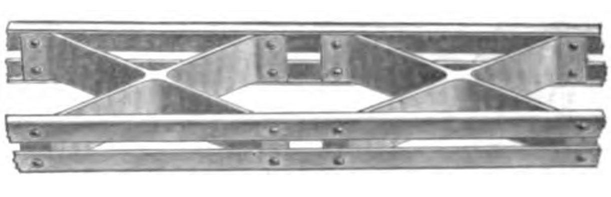


FIG. 2.—BROWNLEE ELECTRIC RAILWAY POLE.

THE PHŒNIX LAMP CO.

The above named company was incorporated December 31st in New Jersey, with a capital of $100,000, and will repair incandescent lamps. William Roessler, A. Greenberg, Ernest C. Keib, Lloyd M. Mayer and R. T. Macdonald are the incorporators.

THE DETROIT ELECTRICAL WORKS.

The Detroit Electrical Works are now ensconced in their mammoth new factory on Woodward avenue, and every department is in a continuous state of activity. Having recently had the pleasure of inspecting the factory we cannot express our appreciation too strongly at the way their work is carried on in its complete and thorough treatment of detail under the able guidance of Messrs. W. A. Jackson, C. A. Benton and Frank B. Rae. Amongst other apparatus ready for shipment, seven of the trucks for the electric street railway at Aurora, Ill., of the new Taylor pattern, manufactured by the Gilbert Car Co. and equipped with the 30 h. p. Rae motors now so well and widely known, and two of the four 80,000 watt generators, were especially noticeable, their excellent mechanical and electrical workmanship indicating high efficiency and great durability.

A novel departure has been made in illuminating and operating the machinery throughout the building. It is lit by incandescent lamps, which are run from the regular 500 volt street railway current furnished to the electric road which runs past the door; and each department is operated by a separate motor running on the same 500 volt circuit, thus demonstrating in the most forcible manner the perfect adaptability of the railway current for both lighting and power purposes. A quantity of special electrical machinery was also being tested before shipment for use in mining and other special work to be operated from street railway circuits. One feature of great and impressive interest is the fact that this company do all their work themselves, having their own foundry, making their own gearing, and last, but by no means least, insulating their own wire, to which latter point they attribute the fact that they have had no armature burn-outs, other than one which was caused by lightning. Their street railway system is now receiving in full measure the widespread attention and adoption which, from its features of simplicity, carefully worked out details and general excellence, it deserves.

DETROIT TRADE NOTES.

THE LOCKWOOD INSTRUMENT COMPANY are doing an active business in their central station measuring instruments. They have recently brought out and already sold a large number of new ammeter plug switches for arc switch boards for inserting the arm, etc., safely and expeditiously in the circuit. This was designed by Mr. Joseph E. Lockwood, and this device in its essential usefulness and reliability is a high tribute to his thoroughly practical inventive genius.

THE DETROIT DYNAMO CO. are pushed to their utmost capacity turning out their "King" dynamos for plating work, and are also manufacturing quite a number of lighting machines up to a capacity of 100 lights. They will probably considerably enlarge their facilities in the near future.

THE MARKLE ENGINEERING CO. are meeting with excellent success with their many electrical specialties, and "Stoddard" Rosette cut-outs are selling like hot cakes.

A. D. CAMPBELL, one of the pioneers in electrical construction work, is kept right at it and continually adding to his record of the number of lamps he has put in, wired, changed around, taken out and so forth, which has reached some astounding figures now and shows that Detroit has a very fair share of incandescent lighting and perhaps a greater number for its size than any other city.

THE DETROIT MOTOR CO., whose machines have made such a favorable record in the electrical field, are turning out at their large new factory at Cass avenue and the railroad a larger quantity of their motors and also of their new generators, recently illustrated in our columns, both of which are the work of Mr. Harry Blades, the electrician of the company, and which in their appearance and operation evince his high skill as a designer of electrical machinery.

THE FISHER ELECTRICAL CO. report business in construction and installation work as good. The Fisher dynamo is of quite unique construction, being wound with 3 coils, that at the neutral point of the field magnets being the shunt coil and the other two around the polar projection at the most efficient point, the series coil; and it is so perfectly compounded that all the lights but one can be thrown off at the same instant without a flicker on the solitary one in circuit or a spark at the brushes, which are fixed in one position on the commutator and need no adjustment, no matter how the load varies. Mr. Fisher has several of these machines of large capacity ready for shipment and is building several more.

THE COMMERCIAL ELECTRIC CO., who handle electric light power and all kinds of supplies, are well loaded with orders for all classes of goods and are doing a constantly and rapidly increasing business.

MR. JOSEPH E. LOCKWOOD, of Detroit, who recently resigned from the managership of the Brush Electric Light Co. there, has not as yet made any permanent connection with any company, although he has had numerous flattering offers. He is engaged just now in designing a special switch board for the Narragansett Electric Light Co., of Providence, R. I., for their alternating system and will embody in it quite a number of novel and advantageous ideas. He is also doing some special engineering work for the Detroit Motor Co.

THE DETROIT SHEET METAL AND BRASS WORKS are manufacturing a new and very efficient dynamo and will undoubtedly meet with the best of success, as their machines are of substantial build and scientific design with many important improvements in detail. They are also preparing to furnish a direct driven equipment for ship work of a most reliable and excellent character. Their apparatus is being designed by Mr. Fuller, who has certainly made some very progressive departures in his work.

THE MICHIGAN ELECTRIC CO., who have been doing a large business in repair work, have some new things in store for the electrical field, and will add facilities to enable them to cope with the growing repair business and to carry out manufacturing work on an extensive scale.

NEW ENGLAND TRADE NOTES.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., are making a specialty of iron roofs for electric light and power stations, and are acquiring a well deserved name for their light and graceful structures. Probably the largest and most important roof which they have yet built for this purpose is the one for the Narragansett Electric Light Co., of Providence, though they have since fitted up many others, and have a large amount of similar work on hand now. They have issued two very complete and interesting catalogues with excellent cuts showing in detail a few of the roofs which they have recently built. A careful perusal will well repay every electrical engineer engaged in designing central stations.

THE EASTERN ELECTRICAL SUPPLY & CONSTRUCTION CO., of Boston, have been appointed general Eastern agents for the Card Electric Motor and Dynamo Co., of Cincinnati, O. These motors, which were recently illustrated in our columns, are made for use on both arc and incandescent circuits, and run from ¼ to 30 h. p. They have also recently become exclusive agents for the Erickson insulating coupling and the Happoldt cut-out, a device for cutting out electric gas lighting batteries when a ground or short circuit occurs.

THE OTIS ELEVATOR CO., through their branch office at 72 Mason Building, Boston, are installing an electric elevator in the Shawmut Building, 146 Franklin street, Boston, for Rodgers, Burdett & Co. An 8¾ h. p. Eickemeyer motor is used, and it will lift a total weight in the elevator of 1,500 pounds at the rate of 250 feet per minute. The motor is fitted with an automatic regulator and is operated by a lever in the car. In the car also is an indicator for telling which way the machine is set, so that the operator can tell whether it is set for going up or down. The motor is geared with one reduction to the hoist by means of a worm and worm wheel, and is connected to the ordinary 220 volt Edison underground system.

THE JOHNSTON ELECTRIC TRAIN SIGNAL CO. have removed their headquarters from 620 Atlantic avenue, Boston, to Woburn, Mass., where their factory is situated. Mr. G. S. Russell, of Marlboro, has been elected assistant treasurer of the company.

WESTERN TRADE NOTES.

MR. G. A. EDWARD KOHLER will continue as Western agent for the Eddy Motor Co., of Manchester, Conn., they having decided to retain the services of so excellent and successful a representative, and will not join the Illinois Electric Material Co., as stated, this company having released Mr. Kohler to continue in his former line.

THE GREAT WESTERN ELECTRIC SUPPLY CO. report business for the New Year as starting out with remarkable briskness, and the indications are that they will do a larger business than ever during the ensuing year. They are making arrangements to place on the market a number of new specialties in lighting and railway supplies of the higest merit.

A. L. IDE & SON, the well known engine builders of Springfield, Ill., are doing a very brisk business, and their new tandem compound engines are meeting with that extended success and adoption which such an excellent and highly efficient engine deserves. They are just shipping 7 150 h. p. Ideal tandem compound condensing engines for the Davenport & Rock Island Street Railway Co. The power plant will be located in Rock Island, Ill., and supply power for this company's lines in the three cities of Davenport, Rock Island and Moline.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

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THE INVENTORS OF THE ELECTRIC MOTOR.—V.

WITH SPECIAL REFERENCE TO THE WORK OF THOMAS DAVENPORT.

BY

Franklin Leonard Pope

(Conclusion.)

THE narrative of the active life and labors of Thomas Davenport in the field of electro-magnetism and its application as a motive power, has now been brought to a close. It only remains for me to sum up, so far as may be, what I conceive to be the true significance of his work as a part of the general history of the industrial application of electro-magnetism, and by way of preface, to say a few words regarding the personal characteristics of the man.

Although forty years have passed since Davenport was borne to his humble grave under the shadow of the stately elms of Brandon, there are still living many old residents, his former friends and neighbors, who well remember him, and who by common consent, speak of him as one who received, and who in the fullest measure deserved, the respect and esteem of the community in which he lived. However visionary his schemes may have appeared to many of his townsmen, there seems to have been but one opinion as to the high character and substantial worth of the man himself.

Thomas Davenport was pre-eminently a student, a thinker and an originator; a strikingly characteristic type of a class of minds to whom the world always has been, and always will be, indebted for its grandest mechanical conceptions. Modest and unassuming in his intercourse with his fellow men, reticent in speech, but cheerful and kindly in manner, and by no means lacking in that dry humor which seems almost inseparable from such a nature, he nevertheless possessed, beneath a peculiarly mild and gentle exterior, a determined and resolute perseverance but little removed from obstinacy, which poverty, adversity and disappointment were utterly powerless to overcome.

From the very moment when he first witnessed the exhibition of the mysterious power of Henry's electro-magnet, the conception of utilizing its invisible force for the propulsion of machinery took possession of his mind and thenceforth occupied it almost to the exclusion of every other consideration. He studied, he pondered, he experimented. Seeking from the beginning to produce continuous rotary motion, with the unerring instinct of the born inventor, in his very first essay he grasped what I have defined as the essential principle of the electric motor, the combination of moving and fixed electro-magnets, one reversible and the other non-reversible; and however extensively and widely he may subsequently have experimented in other directions, he never once loosed his grasp of this fundamental conception.

It may be asked whether it is certain that this conception is due to Davenport alone. It is true that in an absolute sense, this question at this late day can only be answered by the light of internal evidence. Every one who has much intercourse with inventors must have observed that when two minds have wrought upon a mechanical problem until success has crowned their efforts, it is ordinarily quite impossible even for the parties immediately concerned to dissever and distinguish their respective contributions to the general result. Yet the experienced observer, familiar with the mental characteristics of the varying types of the creative mind, usually finds little difficulty in reaching a conclusion which is at least satisfactory to himself. He only needs to know the two men to know in what manner and by what mental processes the ultimate result must have been reached.

From the moment that Davenport declared, in the presence of the little assemblage at Crown Point, his intention of producing rotary motion by means of electro-magnetism, it is certain that he never for one moment permitted himself to doubt that he would ultimately accomplish that result. He was fortunate in having a coadjutor like Smalley, young, enthusiastic, a natural mechanic and a willing worker; and it is altogether probable that to the latter is largely due the embodied form and structure of the machine, particularly the contrivance of the mechanism employed for effecting the reversal of the current which is shown in the sketch accompanying the specification of 1835. It is not unlikely that the design of the first metallic commutator may also have been due to him; but the fact remains, that the master mind, wholly absorbed in the subject, and possessing the determination and the capacity to succeed in spite of every obstacle was that of Davenport. Had Smalley not been at hand to assist him, some other person would have been found. Had it been necessary for him to carry on his work alone, he would have done it. When a mind possessing the indomitable perseverance of that of Davenport, is once in possession of an original idea—the conception of something to be done—its ultimate accomplishment, whether with or without the assistance of others, is as certain as fate. It is the story of every great invention; poverty, ridicule, discouragement, may defer, but are powerless to prevent, the development of an idea.

In the argument before the Supreme Court of the United States in the Telephone case, the learned counsel for the complainant remarked:—

> It is of common experience that the maker of a great invention which originates a new art, seldom has the technical skill and turn of mind which produces the best apparatus. . . . It is an interesting fact that the particular forms Watt thought of when he took out his patent, were practically so ineffective that it required ten years' unremitting work of himself and Boulton, the best machinist in England, before an engine was produced which was commercially satisfactory. But since he took his patent, no engine has ever been constructed which condensed the steam in the working cylinder.

Many instances might be cited as evidence as the truth of this statement. Not only Watt, but Fulton, Morse, Bessemer, Bell, and to mention a very recent instance, Rogers, the inventor of the wonderful typograph machine, were men of only ordinary mechanical skill, and were almost wholly indebted to others for devising and working out the mechanical contrivances in which their conceptions were embodied, and by which only their work could be rendered useful to mankind. Yet this fact does not in the least detract from their individual merit as inventors of the highest type, and as benefactors of the human race. I have seldom seen this idea more forcibly expressed than in a decision of Judge Kane, rendered many years ago in an important patent case, in which he said:

> All machines may be regarded as merely devices, by the instrumentality of which the laws of nature are made applicable and operative to the production of a particular result. He who first discovers that a law of nature can be so applied, and having devised machinery to make it operative, introduces it in a practical form to the knowledge of his fellow men, is a discoverer and inventor of the highest grade—not merely of the mechanism, the combination of iron, brass and wood, in the form of levers, screws and pulleys, but the force which operates through the mechanical medium—the principle—or to use the synonym given for this term in the act of 1793, the *character* of the machine, ... the essential principle which his machine was the first to embody, to exemplify, to illustrate, to make operative, and to announce to mankind.

I have expressed the opinion that the combination of the moving and fixed electro-magnets, one reversible and the other non-reversible, must be regarded, in the light of our present knowledge, as the essential principle of the electric motor. The experience of the past few years has demonstrated beyond question, that the largest motors yet made, show as high, if not a higher, net efficiency than the smaller sizes, and in fact it has not as yet been found practicable to construct an efficient motor of any considerable power upon any other principle. A moment's reflection serves to show the impracticability of organizing a large motor, either with permanent magnets as in Sturgeon's plan, or with non-reversible electro-magnets and neutral armatures as in Edmondson's plan, while on the other hand, by employing the principle introduced by Davenport in his pioneer machine of 1834, no apparent limit to the dimensions or power of the motors which it is possible to construct has yet become manifest.

In our own time, when the doctrine of the conservation of energy is so inseparably interwoven with every conception of the mechanical and chemical interactions of the natural forces, it is wellnigh impossible for us to realize that in Davenport's day, this fundamental law was wholly unknown, or at most had been only dimly perceived by one or two of the most profound philosophers of the day. Davenport himself lived and died in the full conviction that the day which should witness the triumph of electro-magnetism over steam was close at hand. There is much reason to hope that ere many years have passed, his cherished belief and expectation will prove to have been not wholly without foundation. Undoubtedly he also believed that voltaic energy was in like manner destined to take the place of coal energy. In his time science had not sufficiently advanced to enable the latent fallacy of this idea to be detected and demonstrated. It is not to have been expected that a humble village artisan, knowing literally nothing of science beyond that which his own discoveries had taught him,[1] should have mistrusted the existence of a law of equivalence between the forces of nature, which was as yet undiscovered and even unsuspected by the most learned philosophers of the day. The following extracts, selected at random from many which might be cited, give ample evidence of the views which generally prevailed among scientific men in relation to this subject, prior to the year 1840. In his treatise on the steam engine, then recently published, and considered a work of high authority, Dr. Lardner had said :—

> Philosophy already directs her finger at sources of inexhaustible power in the phenomena of electricity and magnetism, and many causes to combine to justify the expectation that we are on the eve of mechanical discoveries still greater than any which have yet appeared ; and that the steam-engine itself, with the gigantic powers conferred upon it by the immortal Watt, will dwindle into insignificance in comparison with the hidden powers of nature still to be revealed, and that the day will come when that machine, which is now extending the blessing of civilization to the most remote skirts of the globe, will cease to have existence except in the page of history.

At the meeting of the British Association in 1840, Prof. Jacobi presented to that body a very carefully prepared paper "On the Principles of Electro-Magnetical Machines," in the concluding portion of which he said :—

> I consider that there will not be much difficulty in determining with sufficient precision the duty of one pound of zinc, by its transformation into the sulphate, in the same manner that in the steam engine, the duty of one bushel of coal serves as a measure to estimate the effect of different combinations. The future use and application of electro-magnetic machines appears to me quite certain, especially as the mere trials and vague ideas which have hitherto prevailed in the construction of these machines have now at length yielded to the precise and definite laws which are conformable to the general laws which nature is accustomed to observe with strictness, whenever the question of effects and their causes arises.[2]

The eminent English philosopher, James P. Joule, of Manchester, in a communication containing an account of some of his quantitative experiments and investigations in electro-magnetism, expressed himself as follows :—

> I can scarcely doubt that electro-magnetism will eventually be substituted for steam in propelling machinery. If the power of the engine is in proportion to the attractive force of its magnets, and if the attractive force is as the squares of the electric force, the economic effect will be in the direct ratio of the quantity of electricity, and the cost of working the engine may be reduced *ad infinitum.* It is to be determined, however, how far the effects of magnetic electricity may disappoint these expectations.[3]

So late as 1851, Professor Page, in discussing the question of the relative cost of steam and electric power, as affected by the then recent investigations of Joule, remarked :—

> We have no proof of any such relation of electricity to heat as to make the mechanical power of one the measure of the mechanical power of the other. Whatever may be the connection and analogy between heat and electricity, we must consider them as distinct forces in their mechanical relations.[4]

The subsequent researches of Grove, Mayer, Liebig, and more particularly of Joule himself, ultimately established the law of the equivalence of forces upon the firm and enduring foundation of experimental demonstration, and confirmed the opinion long before expressed by Henry, that the endeavor to find in voltaic electricity a substitute or a rival to coal-power, must, from the nature of things, be an utterly hopeless one.

The publications made by Professor Page at various dates between 1837 and 1855, and the interesting correspondence between Page and Davenport which has already been given, show that the conceptions of the two men, both in respect to the most desirable principle of construction of the electro-magnetic motor, and as to the possible limits of its power, were widely at variance ; but time, which proves all things, has shown conclusively, that of the two, the views of Davenport were the more correct. The opinions of Page are indicated in the extracts which follow, taken from articles written by him at various times :

> Since the announcement of Mr. Davenport's invention, the innumerable experiments which have been performed in this country, in England, on the continent of Europe, and even in the East Indies, have all contributed to prove that the smallest engines which have been made, have had by far the greatest proportionate power. Since I first gave the subject any attention, I have had sixteen different models constructed, each involving distinct principles. From all these experiments the inference is still the same, viz., the fewer the magnets and the smaller their size (within certain limits), the greater the ratio of mechanical power obtained.[5]
>
> Practically we have already been taught, that (unlike other powers, where the largest engines are the most simple and least expensive) electro-magnetic engines, above a certain limit, increase in complication and expense and in a much greater ratio than the power obtained. *To ascertain this limit, the precise point where economy ceases, is now the great, and ought to be the only, object of research.*[6]
>
> I must premise here (as I have heretofore expressed myself) that I *do not suppose this power capable of indefinite increase,* and in giving this description to the public, I am only selecting from the multitude of machines I have constructed, such forms as obviously economize a given galvanic power. A number of ma-

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[1] "This he effected in a country village, unaided by scientific knowledge, by books, or by the encouragement of men of superior attainments, or with kindred spirits. Whatever may be the result of his labors, his merits are of a high order, and he has proved himself well worthy of the most splendid success. Should his machine finally accomplish that which he and many of his friends anticipate, its value will be incalculable." THOMAS P. JONES: *Journal of Franklin Institute.* [2d ser.] xxiv, 342.

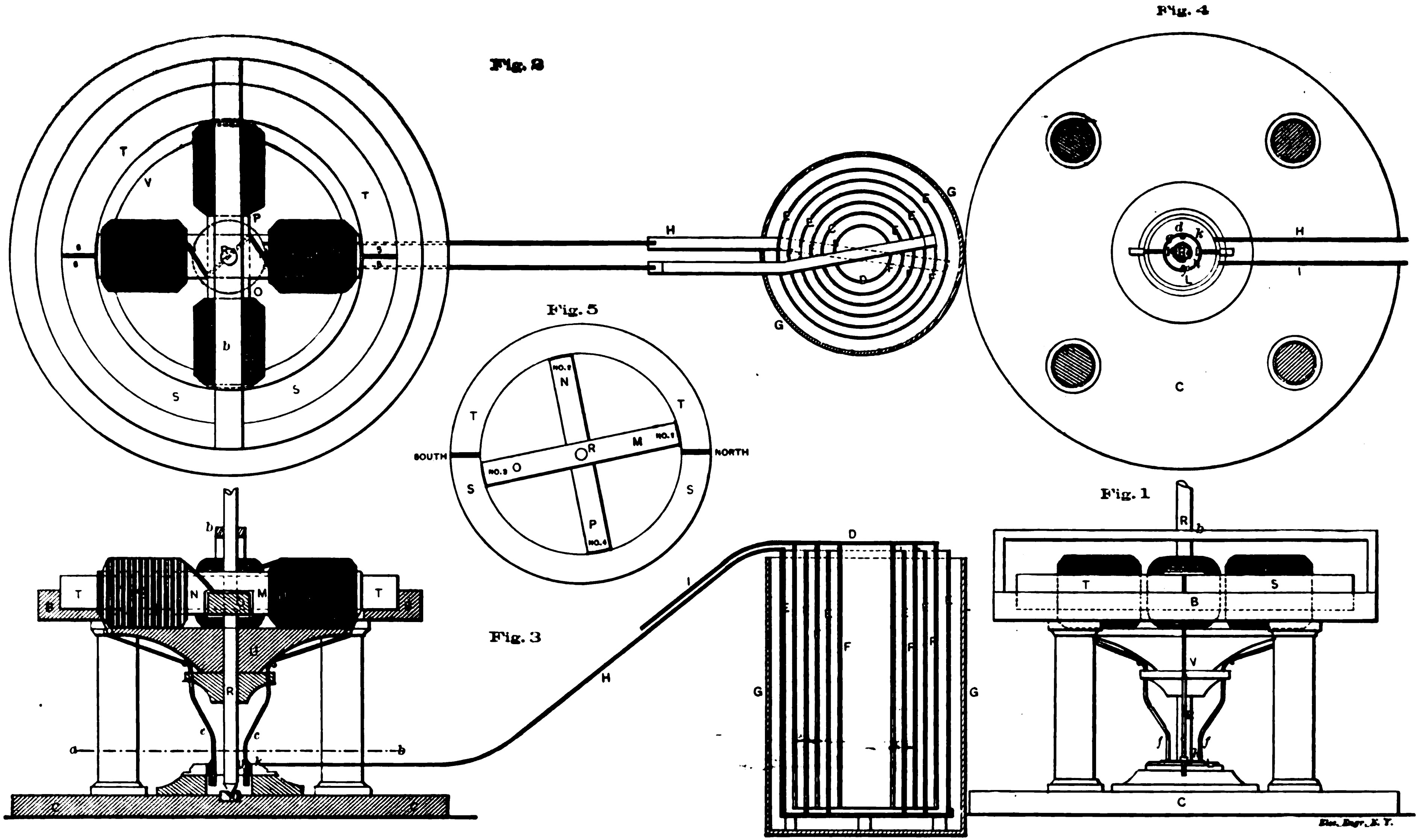
[2] Sturgeon's *Annals of Electricity*, etc., vi, 159.

[3] *Ibid*, iv, 135.

[4] *Scientific American*, (1st series) vi, 315.

[5] *Amer. Jour. Science*, lxxxv, 106.

[6] Ibid, xxxv, 108.



Drawing Accompanying Davenport's British Patent.

[Made to scale from actual Working Machine.]

Fig. 1, elevation.—Fig. 2, plan.—Fig. 3, vertical tranverse section.—Fig. 4, horizontal transverse section in plane of *a b.* of Fig. 3.—Fig. 5, plan of arrangement of magnets.

B platform; C base; D battery, consisting of concentric cylinders of copper E and zinc F, immersed in vessel G containing sulphate of copper solution; H I, positive and negative conductors; K L insulated commutator segments fixed upon vertical shaft R. M N O P cores of electro-magnets; Q Q Q Q helices of insulated copper wire; *a b* bearings of shaft R. *c d e f* commutator springs; V support for electro-magnet; S T semi-circular permanent steel magnets; 5 5 north poles and 6 6 south poles of permanent magnets.

> chines wherein *the poles of the magnets were changed*, and others wherein the poles of the magnets were not changed, but both systems, the stationary and the revolving, were rendered magnetic and non-magnetic at intervals, *have been laid aside as not worth describing.*[7]

So also in his letter to Davenport of April 28, 1838, he says :—

> I feel very sure the power will be useful to the extent I have above named (a power equivalent to one or two men), but for reasons which I can make conclusive to any one, *I do not believe in its indefinite increase.*[8]

The subsequent comment of Davenport upon this opinion, is a peculiarly significant one. In his letter to Page of October, 1850, he says :—

> Since I first saw the power of the electro-magnet exhibited, any idea that the power could not be indefinitely increased, seemed to affect me with a peculiar disagreeableness.

So also in his letter to Smith in 1839, he had said:—

> I have no doubt but that *the power is unlimited*, which can, and ultimately will, be successfully applied to all purposes for which steam power is now used.[9]

This difference of opinion was radical, and it extended to the details of the method of applying the electro-magnetic power. In his letter of April 28, 1838, Page says: "My main object has been to prevent retardation or back action. My plan is to cut off the galvanic current from both systems of magnets instead of changing poles as they arrive at equilibrium. The advantage of this I have fully tested."[8]

In an article written a year later, he remarks :—

> Change of poles cannot be introduced in a machine, for the following reasons :—1. It requires time; and during this time, the magnets which change poles are attracted and retained (retarded?) somewhat by those which do not change. 2. Similar poles will attract and produce back action; for unless the magnets which change poles be favored by excess of battery or superior conductors, they cannot receive near the same charge as those which do not change: for first, there is magnetism of an opposite character to be overcome; and secondly, two breaks in the galvanic circuit are necessary to produce change of poles. 3. Two magnets which have a statical repelling power, that is, a power which will merely keep them asunder when the machine is at rest, will attract each other when the machine is in motion. This singular fact is a consequence of secondary currents.[10]

So far as I have been able to ascertain, the views of Professor Page in this particular, remained unchanged throughout the whole course of his subsequent experimental labors. In every attempt made by him to produce electromagnetic power on anything like a large scale, as, for example, in his locomotive, and in the other experiments made under the Congressional appropriation, he appears to have consistently adhered to the theory that the best results were to be attained by simply cutting off the current from the magnets, without reversing polarity. Davenport, on the other hand, with equal persistency, adhered to the plan of reversing the polarity of one set of magnets twice in each revolution, and out of the very large number of machines constructed at different times by him or under his direction, the only instance I can find in which this principle was departed from, is in the case of the two or three helix machines which were built in New York between 1838 and 1840.[10a] The results of modern research and experience, have abundantly verified the correctness of Davenport's ideas, and have shown that the "peculiar disagreeableness" with which the notion of an assignable limit to the power of electro-magnetism affected him, was but a prophetic manifestation of the instinct and inspiration of the true inventor.

The course of Davenport and Cook in transferring their invention to an incorporated company, for the avowed purpose of raising money by the sale of shares to reimburse them for their expenditures, and to provide means for conducting further experiments on a scale large enough to demonstrate the utility of the invention, met at the time with a considerable amount of adverse criticism, an example of which among many others may be found in a paper on Electro-Magnetism as a Motive Power, by Professor Page, published in 1839, from which the following is an extract :

> It is much to be regretted, that in our country the invention should be a subject of mercenary speculation, when in reality it has no value except as an experiment, and that the public have been so far misled, as to withdraw that countenance and encouragement which the experiment really merits. We cannot but deplore, that such an interesting branch of science should be so traduced, and that the very name of electro-magnetism should be coupled with empiricism.[11]

So also, a prominent scientific journal in an editorial paragraph, observed:—

> We rather regret that this interesting application of electro-magnetism is attempted to be sustained by an appeal to the hope of immediate profit.[12]

I cannot but regard this implied censure as unjust and unmerited. Examine critically as one may every line of the correspondence and writings of Davenport and I venture to say there can be found not one trace of a self-seeking spirit, not the faintest expression of a desire to make money from his invention, beyond the modest and reasonable expectation of a comfortable support for himself and those dependent upon him. It is but seldom that he refers, even casually, to the innumerable hardships and inconveniences which he and his family must have not infrequently suffered from want of means; but on the other hand, we find more than once, expressions of profound regret at being unable to command the financial support which was essential to him in perfecting and carrying out his self-imposed task of giving to the world an economical and efficient substitute for what he calls, and was at that time justified in calling, "the murderous power of steam." For my own part, I can see no reason why the action of Davenport and Cook, in taking part in the organization of a stock-company whose earnings were expected to come from the future development of the invention, was not in every respect as legitimate and proper at that day as it would be at this. It is certain that neither of the principals could have entertained the slightest intention of misrepresenting the circumstances, or of misleading the public. It appears to have been perfectly well understood by all concerned, that the invention was not claimed to have passed beyond the stage of a promising experiment, but nevertheless, that if the proceeds of the sales of stock enabled a large engine to be constructed and put in successful operation, the future of the enterprise might reasonably be expected to be highly profitable to the shareholders. It is not impossible that misrepresentation and even fraud may have been practiced upon some of the shareholders by the agent who had been entrusted by Davenport and Cook with the management of the business of the company, but the records show that no effort was spared by them to put a stop to his irregular proceedings as soon as they became aware of them. One needs but to read the letters of Davenport, to be impressed with the conviction that he was a man of childlike simplicity and transparent integrity of purpose, and that the single object to which he devoted every energy of his life, was not the accumulation of money nor the gratification of self, but the development of what he believed to be an invention destined to confer priceless benefits upon his fellow men.

In conversation with some of the more elderly residents of Brandon, among whom were a number of acquaintances and friends of Davenport during his lifetime, I have been more than once assured that he was the real originator of the electric telegraph. This statement has recently been made with some particularity in the columns of the local press :

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[7] *Amer. Jour. Science*, xxxvi., 350 (1839).

[8] *Ante*, p. 71.

[9] *Ante*, p. 94.

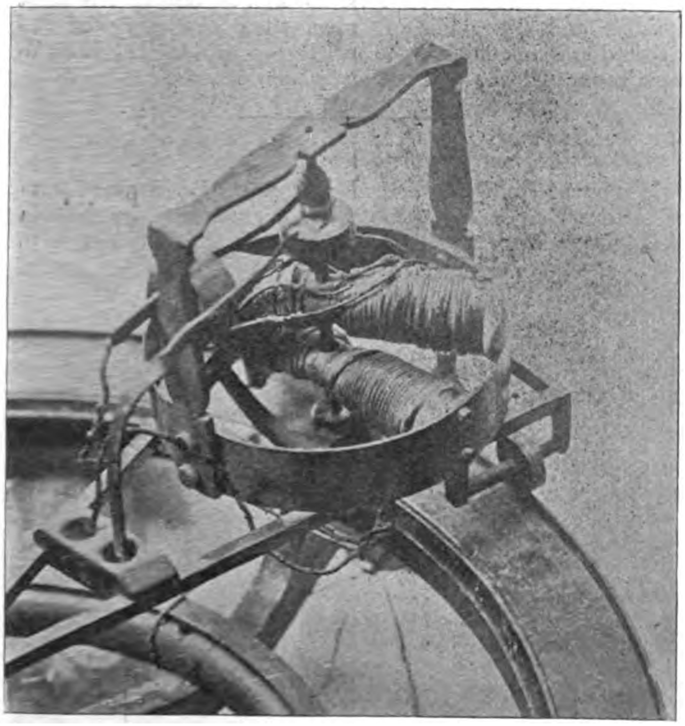
[10] *Amer. Jour. Science*, xxxv, 109 (1839).

[10a] It does not appear that Davenport ever took out a patent in this country on the helix machine. It was, however, patented in Great Britain, as a communication from abroad, on July 11, 1838, by Lewis C. Callet.

[11] *Amer. Jour. Science*, xxxv., 107.

[12] *Ibid.*, xxxiii, 194.

> [*From the Brandon* (*Vt.*) *Union, December* 19, 1890.]
>
> There are but very few outside this immediate vicinity that are aware of the fact that the first telegraph line in the world for transmitting signals over a wire by electricity was erected in Brandon, and by a Brandon man. Yet such was the case, and this town has the honor of being the first spot where this mighty invention of modern times was put to practical use. . . . Mr. Davenport, then living in Brandon, in connection with Mr. Smalley, now living at Forestdale, experimented considerable in electric appliances. Long before Prof. Morse had projected anything of the kind, these gentlemen had a wire that connected their two residences, on which were transmitted dispatches by means of electricity, using a battery, and which gave by machinery the sound as now heard from machines in ordinary use. After this wire had been in operation for some length of time, Mr. Davenport moved to New York and began the publishing of the *Electro-Magnet*, being printed by a machine propelled by electro-magnetic force, as the paper claims upon its title-page. While in New York we are informed that Prof. Morse called upon Mr. Davenport, and was struck with his discovery, and then began to make improvements thereon, inventing the Morse alphabet. He then applied it to Mr. Davenport's discovery which has proven to be such a magnificent success. To Prof. Morse belongs a great deal of honor for bringing before the public the wonderful merits and advantages of telegraphy, but the discovery and origin of this great invention justly belongs to Thomas Davenport of Brandon.



WORKING MODEL OF DAVENPORT'S ELECTRIC LOCOMOTIVE.

[*Photograph from the Original in the Cabinet of the Troy Female Seminary. Supposed to have been constructed circa* 1837.]

No claim of this kind is asserted or even remotely hinted at in any of the letters or papers of Davenport which I have examined. On the other hand, in response to a specific inquiry as to the telegraph line which Davenport and himself are reputed to have constructed and used, Mr. Smalley has stated that in the course of their experiments in 1834, they discovered that physical effects could be produced by the electro-magnet through a considerable length of wire, and that any length at their command seemed to make no difference in the *time* required to effect the result, but that no attempt was made by them to transmit intelligible signals, or to construct apparatus for that purpose. The fact first mentioned by Mr. Smalley, was, however, well known at the date mentioned (1834), having been fully demonstrated in the experiments made by Henry in Albany in 1830–31.

The source of this telegraphic legend may undoubtedly be traced to a conviction which Davenport is known to have entertained, and honestly so, that Morse's telegraphic apparatus was an infringement upon his own patent of 1837. In a letter written from Brandon, under date of April 18, 1846, to Dr. Thomas P. Jones, of Washington, he writes :—

> I learn from Mr. ——— who has recently been in Washington, that it is your opinion that Prof. Morse's application of electro-magnetism to propelling his machinery for the telegraph is an infringement on my patent. I have long thought so myself, but not knowing how to proceed in consequence of my poverty-stricken situation, I have taken no steps in the case. . . . As the claim granted me is for "applying magnetic and electro-magnetic power as a moving principle for machinery," it is as clear as the solar light that Morse must be using what of right belongs to me.

In explanation of this erroneous opinion on the part of Davenport, it must be borne in mind that at the date when the above letter was written, the history and chronology of the invention of the telegraph had never been made public ; it was first brought out in the course of the exhaustive legal investigations consequent upon the interference proceedings between Morse and Bain, and the suits against O'Reilly and others by the Morse patentees at a still later date. The very earliest published notice of Morse's invention appeared in the New York *Journal of Commerce ;* a communication over Morse's own signature, accompanied by a sample of the writing of the apparatus then used, which was dated September 4, 1837. As this was some two or three months after his visit to Davenport's laboratory, the latter, by a very natural process of reasoning, assumed that Morse had merely applied his (Davenport's) idea to the movement of another kind of machinery for a different purpose. But at a later date it was established, upon evidence which cannot be gainsaid, that Morse had actually constructed and operated his electro-magnetic recording apparatus in a short circuit in his rooms in the New York University building, as early as November, 1835, more than a year before Davenport and Cook came to New York with their machinery for exhibition.[13]

It is not improbable that Morse was indebted to Davenport for a more effective construction of the electro-magnet than he had hitherto employed, but even granting this, the electro-magnet was a feature which Davenport himself had borrowed from Henry, and which formed no part, *per se*, of his own discoveries.

The patent of Davenport was granted February 25, 1837, under the title of "An Application of Electro-Magnetism to Propelling Machinery." The claiming clause of this patent has been criticised by unfavorable implication, as "a remarkable instance of the granting of a broad claim by the Patent Office to an inventor." It may not be out of place to consider for a moment whether such a criticism is well-founded. The statement is in the following words :

> The discovery here claimed and desired to be secured by Letters Patent, consists in applying magnetic and electro-magnetic power, as a moving principle for machinery, *in the manner above described*, or in any other substantially the same in principle.

Within a few months after the issue of the patent, Davenport, referring to his invention, wrote :

> No departure from the principle of the orginal invention has been or can be made. That principle was *the production of rotary motion by repeated changes of magnetic poles ;* this it is which is secured by patent ; and no peculiarity of arrangement or modification of the magnets can be made to move without adopting the essence of the first invention.

This assertion, although in a strictly literal sense inaccurate,[14] is nevertheless substantially true, inasmuch as every practical motor in use at the present day involves the principle of the "production of rotary motion by repeated changes of magnetic poles." If, therefore, we read into the claim of the patent the mode of operation original with Davenport, viz., the combination of reversible and non-reversible "galvanic magnets" which is described in the specification, as being the organization referred to in the words "in the manner above described," we find that its manner is not only not unwarrantably broad, but that it defines with accuracy and clearness the precise invention which Davenport made; no more; no less.

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[13] In the case of Morse *v.* O'Reilly in the United States Supreme Court, the following witnesses testified to having seen the operation of Morse's electro-magnetic recording telegraph in his rooms in the New York University in 1835 and 1836 : Leonard D. Gale, Daniel Huntington, Osbert B. Loomis, and Robert Rankin.

[14] Neither the prior machine of Edmondson already described (ante, p. 1) nor the helix and core machines, subsequently constructed by Davenport himself and by Prof. Page, make use of the principle of "repeated change of poles." But none of these types of machines have achieved permanent industrial success, in comparison with the pole-changing type, for reasons which are now well understood.

Justice Curtis, in his decision in a leading patent case before the Supreme Court of the United States, has remarked:

> It is this *new mode of operation* which gives it the character of an invention and entitles the inventor to a patent; and this new mode of operation is, in view of the patent law, the thing entitled to protection. . . . . . . Specifications are to be construed liberally, in accordance with the Constitution and the patent laws of the United States, to promote the progress of the useful arts, and allow inventors to retain to their own use, not anything which is a matter of common right, but what they themselves have created.[15]

"In that case," says James J. Storrow, confessedly one of the most learned and able advocates of our own day, "the maturest judgment of the Court was announced by a jurist whose peculiar faculty it was to perceive both the groundwork of a legal rule, its limits, and the limits of its application, and to formulate the whole in language which defined as well as stated." And in a more recent case decided in the same court the venerable Justice Bradley has remarked:

> The whole subject-matter of a patent is an embodied conception, outside of the patent itself, which to the mind of those expert in the art, stands out in clear and distinct relief, whilst it is often unperceived, or but dimly perceived, by the uninitiated. *This outward embodiment of the terms contained in the patent is the thing invented,* and is to be properly sought, like the explanation of all latent ambiguities arising from the description of external things, by evidence *in pais.*[16]

If, therefore, we interpret the claim of Davenport's patent, not only in its relation to the state of the art at the date of its invention, but in the light of the well-considered utterances of the highest tribunal of the land, and compare it thus understood with the definition of the fundamental principle of the modern electric motor which was formulated at the beginning of this series of papers, we shall find that they are substantially identical. The conclusion necessarily follows, that the invention thus identified was conceived and embodied in concrete operative form by Thomas Davenport at least as early as July, 1834, was exhibited and described to others prior to January 5, 1835, and was covered by his Letters Patent of February 25, 1837. If, therefore, this patent, which expired in February 1851, were in force to-day, it is not too much to say, that upon a fair judicial construction of its claim, every successful electric motor now running would be embraced within its scope.

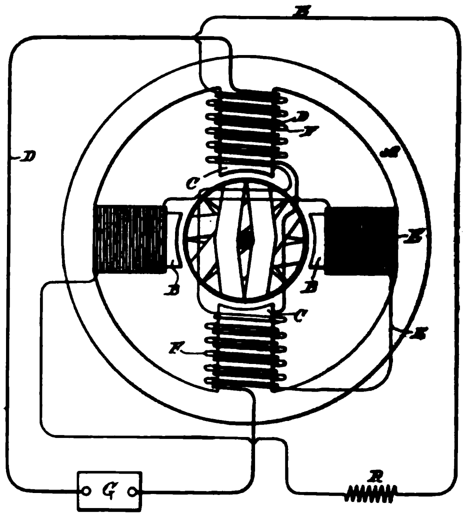
Thomas Davenport was born in Williamstown, Orange County, Vermont, on July 9, 1802. He was descended from the family of the same name prominent in the early annals of the New Haven colony, and was the eighth in a family of eleven children of Daniel and Hannah (Rice) Davenport. His father, who was a farmer, died when he was but ten years of age, leaving the family in indigent circumstances. At the age of 14 he was apprenticed to Samuel Abbott, of Williamstown, with whom he learned the blacksmith's trade. Upon the expiration of his apprenticeship, about 1823, he removed to Brandon, Vt., where he set up business for himself. He married, February 14, 1827, Emily, daughter of Capt. Rufus and Anna Goss, of Brandon, born March 29, 1810. The mother of Rufus Goss was a daughter of the celebrated American traveler, Jonathan Carver. Davenport was prosperous in his business, and shortly after his marriage, built a commodious brick house in Brandon village, and was in a fair way to accumulate a comfortable property, when his attention was directed by the circumstances already related, to the study of electro-magnetism. From that time forward, the history of his labors and the history of the man are inseparable.

Two sons were born to Davenport, both of whom subsequently enlisted and became officers in the war of the rebellion. The elder, George D., a captain in the 5th Vermont Regiment, fell in the battle of the Wilderness; and the younger, Willard G., who is still living, became a clergyman in the Protestant Episcopal Church. The story of the active life of the inventor has been fully told in connection with the history of his work. He died on a small farm in Salisbury, Vt., July 6, 1851, at the comparatively early age of 49, and was buried in Brandon. The immediate cause of his death appears to have been a species of nervous prostration, superinduced by excessive study; and no doubt aggravated by the effects of so many years of toil, privation and disappointment.

If the publication of these papers shall in any measure serve to render tardy justice to the memory of one of the most meritorious of inventors, as well as one of the most amiable and deserving of men, then the story of the "Brandon blacksmith," the writing of which has been to me a labor of love, will not have been in vain.

NEW TESLA ALTERNATING MOTOR.

We have already described a number of different forms of alternating current motors designed by Mr. Nikola Tesla, depending upon a variety of phenomena met with in the employment of alternating currents. One general type of these consists of a machine with, say, four poles, between which is mounted an armature, generally wound with closed coils. On two opposite poles of the field are primary coils connected up in the main circuit. On the same cores are also wound secondary coils which are closed through coils on the other pair of poles. When an alternating current is caused to pass through the primary coils, it energizes directly one set of poles, and induces currents in the secondary coils, which in turn energize the other poles; but the phases of the current in the secondary coils may differ in time from those of the primary current, and hence a shifting of the poles is effected, that imparts a rotation to the motor.



Tesla Alternating Motor.

In the new motor designed by Mr. Tesla, however, two energizing circuits are brought into inductive relation in the motor itself, and the employment of an external induction device is thus avoided. The operation is dependent upon the existence of a certain difference of phase between the currents of the primary and secondary coils, and will be readily understood by reference to the accompanying diagram.

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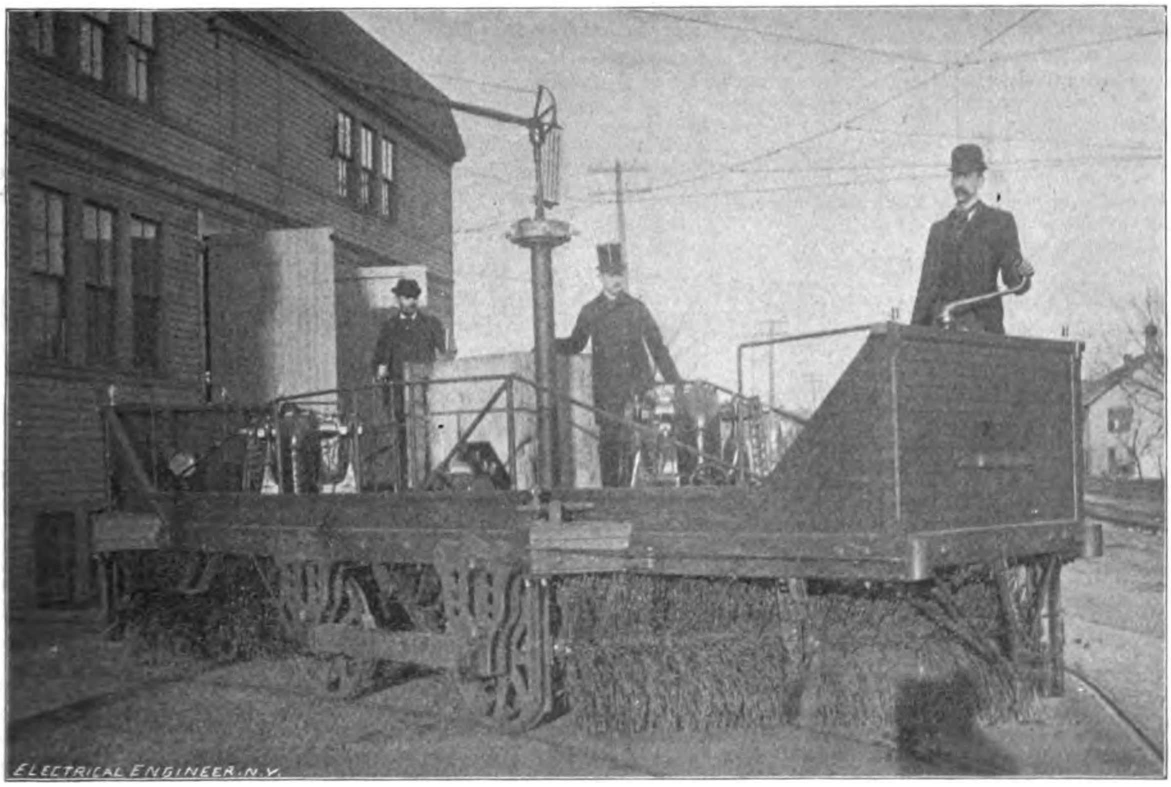
[15] Winans v. Denmead, 15 Howard, 330 (1853).
[16] Bischoff v. Wethered, 9 Wallace, 812 (1869).

Here A represents the field magnet of a motor, which is built up of sections or plates. B and C are polar projections upon which the coils are wound. Upon one pair of these poles, as C, are wound the primary coils D, which are directly connected to the circuit of an alternating-current generator. The secondary coils, F, are wound on the same poles with the primary, and connected with other coils, E, which surround the poles B.

The current in both the primary and secondary coils will lag behind the impressed electromotive force, but to secure the proper difference in phase between the primary and secondary currents themselves, the resistance of the circuit of the secondary is increased, so as to reduce as much as possible its self induction. This is accomplished by making the coils E of comparatively small wire, having but few turns around the cores, or by inserting in the secondary circuit an artificial resistance, R.

In practice, it has been found desirable to wind the armature with closed coils, in which currents are induced by the action of the primaries.



COLUMBIA ELECTRIC SNOW SWEEPER, ST. PAUL, MINN.

THE COLUMBIA ELECTRIC RAILWAY SNOW SWEEPER.

The severe winters met with in our climate make an efficient snow-sweeper a most important adjunct to the equipment of an electric railway. As a successful example of this kind we give in the accompanying engraving a view of a new snow sweeper built by the Columbia Electric Co., of St. Paul, Minn., for the St. Paul & Minneapolis Railways.

The car frames of the sweeper were built by the St. Paul City Ry. Co. and the motors by the Columbia Electric Co. The car is driven by one 30 h. p. laminated field, Gramme ring motor, connected by sprocket gear to the axles of the car. Friction wheels may be used, as shown in the engraving, but this is at some expense of power; the sprocket gear, however, runs with no perceptible noise. A rheostat is placed below the car bed to control this motor, and is so arranged that any speed desired can be obtained, up to a maximum of 15 miles per hour.

One 10 h. p. motor of the regular Columbia type is used to drive each brush, one rheostat controlling both motors. The brushes are run direct from the motor with sprocket and chain. The car, as shown, is open, the motors only being covered. The covers of the two smaller ones are movable, and the large one is accessible through doors.

The car is lighted with a cluster of six lights on the trolley turret, and one on each corner of the car. This is claimed to be one of the most complete sweepers thus far constructed, and will, at a speed of from 4 to 7 miles per hour, remove snow of from 3 to 12 inches deep. In case of very deep drifts the car can be run at very slow speed and the brushes at high speed, thus cutting its way through the drift.

A special advantage of this car is the placing of the motors above the car floor, which protects them from moisture and at the same time enables the motor men to take proper care of them.

NEWBURGH, N. Y.—At a meeting of the board of directors of the Edison Electric Illuminating Company, Mr. Charles J. Lawson was elected a director, in place of the late Mr. John P. Andrews, and Mr. Jas. T. Lawson was elected vice-president of the company, in the place of the same lamented gentleman. The company decided to extend their line underground up Second from Water street to Mortgomery and north through the latter street. It was also decided to go on during the year improving the interior of the plant of the company on Montgomery street.

PACIFIC MUTUAL TELEGRAPH CO.—The directors of this company were elected Jan. 14, among them being A. B. Chandler, D. Townsend, L. D. Parker, J. A. Corby and E. C. Platt.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XII.

(*Copyright, The Electrical Engineer.*)

BY

Herbert Laws Webb

TEST FOR CAPACITY.

The usual method of measuring the inductive capacity of a wire or cable is to compare the charge it is capable of holding with the charge held by a standard condenser of known capacity, the same battery power being used for both operations. As already explained, an insulated wire or cable constitutes a condenser by itself, the wire being one plate and the outer covering the second, with the dielectric for the separating medium.

Insulated wires and cables have a high inductive capacity as compared with overhead wires, partly because the specific inductive capacity of the materials with which they are insulated is much higher than that of air, which forms the dielectric of an overhead line, and partly because they are laid on or in the earth, as the inductive capacity of a wire increases with its proximity to the earth. The inductive capacity of an overhead wire, strung at a height of about thirty feet above the ground, is more than twenty times lower than that of a heavily-insulated underground wire having a dielectric of rubber compound or gutta percha, and more than ten times lower than that of a conductor in an underground telephone cable having a dielectric of cotton and paraffin, or cotton and resinous compound.

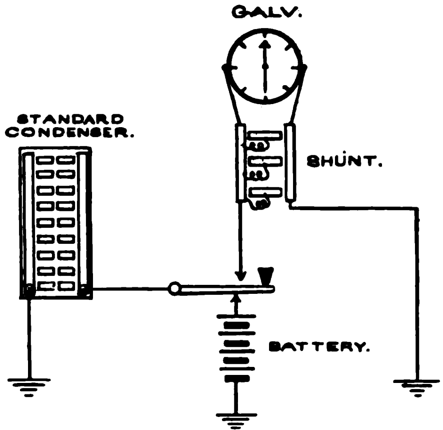


FIG. 32.

It is very important to obtain accurate measurements of the inductive capacity of conductors used for telegraphy and telephony, as this quality of the wire has a distinct bearing on its usefulness; in telephony this is more especially the case, as every hundredth of a microfarad per mile counts for a good deal in limiting the range of transmission, especially where considerable lengths of cable are used.

In Fig. 32 the connections for taking the discharge of the condenser are shown. The battery is connected to the lower contact of the discharge key, the condenser is connected to the lever of the key, and the galvanometer to the upper contact. The second pole of the battery and the other terminals of the galvanometer and condenser may either be all connected together, or put to earth. The short circuit key is held permanently open.

By pressing the lever of the discharge key down, the condenser is charged to the potential of the battery, and by letting it fly up against the upper contact, the charge is released or neutralized and flows through the galvanometer, producing a sudden throw of the needle. This deflection should be noted, as it corresponds, in a certain sense, with the galvanometer constant in the previous test.

From five to ten cells should be used in taking the discharge of the condenser, and the capacity of the condenser should be arranged (see ante, CONDENSERS) so as to have about the same value as the capacity of the wire or cable about to be measured. If the capacity of the wire to be measured is very small, such as would be the case when measuring a short length of telephone cable, or an overhead wire only a few miles long, the capacity of the condenser should be made small by connecting the sections in series, and the battery power should be increased so as to produce a large deflection. It is always best to get as large deflections as possible, as closer readings can be made and the percentage of error is less. If a long cable is to be measured the capacity of the condenser should be about one-tenth or one-hundredth that of the cable, so that the deflection given by the discharge from the cable with the $\frac{1}{9}$th or $\frac{1}{99}$th shunt in the galvanometer circuit shall be about the same as that given by the discharge from the condenser with no shunt.

THE ACTION OF THE TOEPLER-HOLTZ MACHINE.

BY

Marshall Henshaw

IN looking over the files of the ENGINEER, for 1890, a few days ago, preparatory to our annual work in electricity, I found in your issue of June 18, page 478, a communication by Mr. Willyoung criticising a little article of mine on the action of the Toepler-Holtz machine which you printed in the number of May 14, page 306.

Mr. Willyoung thinks I ought to have stated the reason why I deemed the explanation given in *Science* in 1884, and printed in leaflet by Messrs. Queen & Co., was unsatisfactory. That was not my object in writing. I had too great a respect for the author of that article, and also of the one printed in the *Electrician* the same year, to criticise a mere theoretical opinion expressed by either. I wished simply to state in a tentative way, a conclusion to which I have been led by more than ten years' experience with the machine. I referred to the other communications as not "satisfactory to some" (not *hardly* satisfactory," as Mr. W. professes to quote), as a reason for suggesting another. I shall not enter into a controversy with Mr. Willyoung. I have more important work to do.

But as he makes the very positive personal assertion that "Prof. H. could not have verified his" theory "by experiment," I beg leave to say, first, that, if the two proposed theories are "exactly the same" with slight exceptions, as Mr. W. affirms, the experiments in Queen & Co's. laboratory, as far as they have any value, bear equally against both. But, in my judgment, they are radically different. The exceptions are the essential features.

Secondly, I must say (though with diffidence in view of Mr. W.'s confident assertion) that I have tested the machine in a great variety of ways, and the results tend to confirm the theory I proposed. I have employed chiefly the *proof-plane* and two different forms of sensitive electroscopes. I have tested it with the jars on, and with them off; immediately after stopping the plate, and after it had stood a few minutes; and when the machine was in vigorous action I have stopped it, taken off the plate and carried it beyond the influence of the other parts and tested it. The armatures with the glass plate form a sort of condenser, and grounding them does not discharge them, just as grounding the outside of a charged jar does not discharge it. This is shown by the fact, that if the ground connections are removed, and the plate rotated, the machine springs instantly into full action, which it could not do if the armatures were discharged. Moreover, the *residual* charge of the jars leaves free electricity on the plate opposite the whole length of the armatures. These facts vitiate the experiments mentioned by Mr. Willyoung.

When electricity of such high potential is so rapidly produced there is an *electric field* generated all around the machine, and when the rotation ceases, there is free electricity more or less on every part. The all-important question is, What is the condition of the plate when in actions ? As it is difficult to apply tests in this case, we must rest on well established principles of electrical action. These lead me directly to the conclusions which I stated. The theory is merely a little more extended application of the generally accepted explanation of the action of Carré's Dielectric Machine.

My machine has never changed its polarity when in action, though I have charged a battery of 9 two-gallon jars so highly that they have discharged themselves across the unarmored portion.

All these theories profess to explain only the *normal* action of the machine. There are other effects which vary at times even when the conditions are apparently the same, and no one, so far as I know, has attempted to explain them.

THE THOMSON-VAN DEPOELE MINING LOCOMOTIVE.

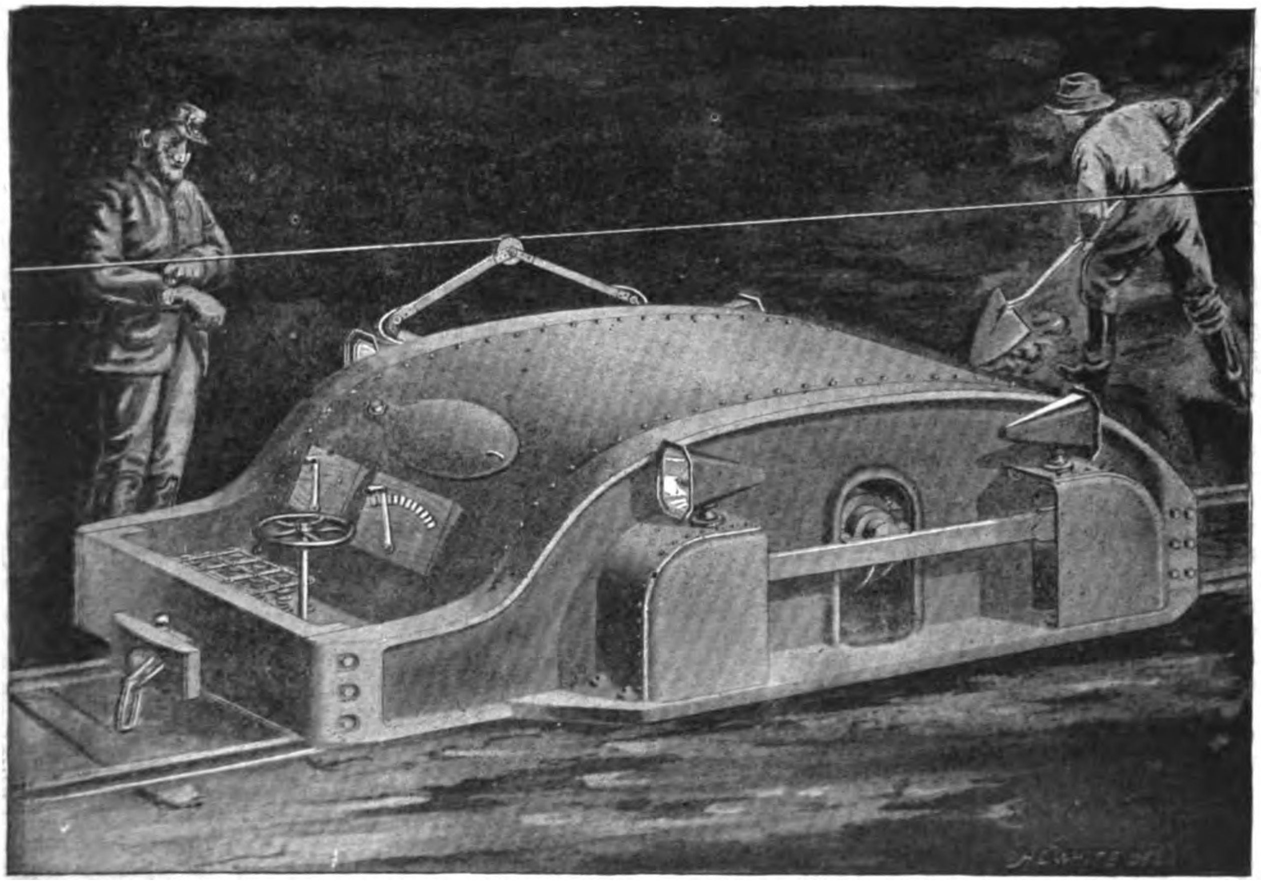
The signal success of the earlier mine haulage installation made on the Thomson-Van Depoele system has demonstrated the position which electricity is to occupy in this field of work. As an example of the most recent advance in this direction, we give in the accompanying engraving a view of the new type of Thomson-Van Depoele electric mining locomotive for underground work, which the Thomson-Van Depoele Electric Mining Company, of Boston, is now building in several sizes.

The machine shown is of 66 horse-power capacity and has a total height of 39 inches from top of rails It is built to operate on tracks of gauge varying from 36 inches to the standard 4 feet, 8½ inches.

The controlling devices are all at one end, and the body of the locomotive being so low that the view is unobstructed in either direction, the operator need not change his position in reversing the motion of the locomotive. Two electric parabolic projectors are provided at each end, making the track clearly visible for long distances.

The trolley is of the double elbow pattern, found so admirably suited to mine work in previous installations. It accommodates itself to the varying heights of the trolley-wire within any reasonable range. The sheet-iron covering makes a complete water-tight armor, protecting the moving parts from danger of falling rocks or bodies of ore and coal.

The illustration shows the locomotive in an enlarged chamber but about to enter a tunnel whose height from top of rail is scarcely four feet; hence the depression of the trolley-wire as shown.



New Thomson-Van Depoele Electric Mining Locomotive.

THE DURATION OF TELEGRAPHIC CURRENTS.

In a recent issue the *Zeitschrift für Elektrotechnik* remarks that a few figures with regard to the duration of currents used in telegraphy may be of interest. In ordinary Morse working the average duration of the signaling current may be taken at .125 second; with the Hughes apparatus currents lasting only from .04 to .05 second are emitted, while with the Meyer multiplex apparatus currents having a duration of as little as .007 second, and with the Delany multiplex of .002 second are sent to line. The lowest figure is, however, reached by the Wheatstone automatic, which, when transmitting at the rate of 600 words a minute, sends out 33,600 currents per minute, or 560 per second, each having a duration of .0018 second.

A SIMPLE METHOD OF DYNAMO DESIGN.—I.

BY

Thorburn Reid.

In the field of electrical engineering everything is so new, the laws and principles are so little systematized and so unstable, as to make rough methods almost a necessity; but that these methods are rough and wasteful, no unprejudiced person will deny. Steam engineering has been reduced almost to an exact science and no doubt electrical engineering will ultimately attain to the same degree of perfection, but many years must pass and much labor be expended by those interested, before this very desirable goal is reached.

The laws governing the flow of electricity in conductors, at least where the current is not subject to rapid variations, are now pretty thoroughly understood, thanks to Ohm's law and the laws deduced from it; but it was not till many years after Ohm's law was stated that its meaning was fully recognized by the scientific world.

We now have a similar law in another branch of electrical science, whose significance and importance are just beginning to be recognized. This law has received no name, for the reason that its statement and development have not been traced definitely to one man. It seems to have been gradually developed from vague germs of thought, till now it has reached a definite mathematical expression. This law, to put it in few words, is simply Ohm's law applied to the magnetic circuit. Rowland, in 1873, was probably the first to express it algebraically, when he wrote $Q = \frac{M}{R}$, where Q represents the number of lines of force sent through the circuit by the magneto-motive-force M, against the magnetic resistance R.

It must be remembered that this is simply a law, in accordance with which the phenomena of magnetism are produced by means of the lines of force of an electric current, or, otherwise. It is not a principle deduced *a priori* from the nature of magnetism and expressing its essential qualities, but simply an expression of what appears to be the relation between the three quantities denoted by the terms of the equation, a relation discovered and verified by experiment and apparently incapable of mathematical demonstration. It is of the nature of an hypothesis, which is used as a tool, until something better is furnished us. It is, however, a very useful tool for the purposes of the engineer and scientist, but, as in the case of most innovations, it requires time and usage before the average workman can be persuaded to use it, and the object I have set before myself in this paper is to render it more practical and better suited to the needs of the engineer by putting it in such a shape that he may use it in designing dynamos, transformers, etc., while using the units and formulæ with which he is already familiar.

The formula is unfortunately complicated by a property inherent in magnetism, which does not confront us when the law is applied to electrical phenomena, namely, that air is sensibly a conductor of lines of magnetic force, while it offers an almost infinite resistance to the passage of the electrical current; and, since all electro-magnetic apparatus must, in the nature of things, be immersed in air, an important path is offered for the passage of lines of force, whose probable effect on the distribution of the magnetism it is difficult to forecast. The amount of this disturbing element must be found out by experiment for each type of machine and allowed for by a term analogous to the factor of safety in structures built to withstand stress.

Another difficulty in applying this formula is due to the lack of uniformity in the composition and magnetic properties of the wrought iron, cast iron and steel commonly used in designing dynamos. These difficulties, however, will apply to any formula which may be used and may only be removed by numerous experiments and comparisons.

As far as I can learn, the formula promulgated by Gisbert Kapp in 1885, seems to be the one now generally used. This formula was a marked advance on the methods in vogue at that time and has been of incalculable aid to the electrical engineer. In May, of the following year, Drs. John and Edward Hopkinson reported to the Royal Society the results of investigations made with an Edison-Hopkinson dynamo, in which they made use of the formula $Q = \frac{M}{R}$, adding to some of the terms of their expression a factor, or coefficient, allowing for the leakage of the lines through the air. For some reason this formula does not seem to have received the attention it deserved from practical men, for the reason, I imagine, that their article contains many equations and long mathematical terms and phrases, and that the French units are used throughout, and the practical man, especially if he is an American, always shies at centimetres and grammes. In Thompson's "Dynamo-Electric Machinery," page 316, their method is much more simply put and its advantages pointed out.

Kapp's formula no doubt owes its popularity to his judicious choice of units and to its simple and clear form of expression, the inch, the ampere-turn and the Kapp-line (6,000 C. G. S. lines) being the units used, thus making necessary a simple division by 6,000 to reduce to volts. The one great objection to this formula is that it is not general enough. It is empirical rather than theoretical. The general formula as he stated it is $Z = \frac{P}{R_a + R_A + R_F}$ where Z is the number of Kapp-lines, P ampere-turns, and R_a, R_A and R_F the magnetic resistances respectively of the air space, armature core and field magnets. This expression is general and of the form $Q = \frac{M}{R}$. When, however, he proceeds to insert the constants for the magnetizing force and the magnetic resistances, he entirely changes the form of his equation and that is the fatal defect in it as arranged for the practical designing of dynamos. The deduction of this formula and its constants will be found in Kapp's "Transmission of Energy," page 107 (either edition), *et seq.*

Kapp first deduces the constant for the specific magnetic resistance of air as 1,880. It is really slightly greater (1,885.7). He then reduces this resistance nearly a quarter, accounting for this reduction by the presence of copper in the air space, which, he says, is more permeable than air. Unfortunately, copper is not more permeable than air, what difference there is being slightly in favor of air, and if it were not so, the difference is entirely too small to account for so large a difference in the specific magnetic resistance, even if the whole air space were filled with copper. The reason given in the first edition is even less tenable than this and was accordingly not repeated in the second. Next, for determining the constants for iron, a permeability of 940 was assumed for wrought iron and of about 600 for cast iron and the formula is said to be good up to 10 lines per square inch. Now, in most cases, the former number is too low and the latter is always too high for the ordinary cast iron used in dynamo machines. The reduction of the air space resistance will offset this discrepancy to some extent, but the relation between the two is not of the proper character to produce correct results.

Now enters our practical man and tells us that he has designed many machines by means of Kapp's formula and that, with the addition of a few constants, he has found that it gave good results and he is very well satisfied with it and does not see why he should be asked to give it up because it is not logically consistent nor mathematically correct.

My friend, your reasoning is very good, excellent, in fact;

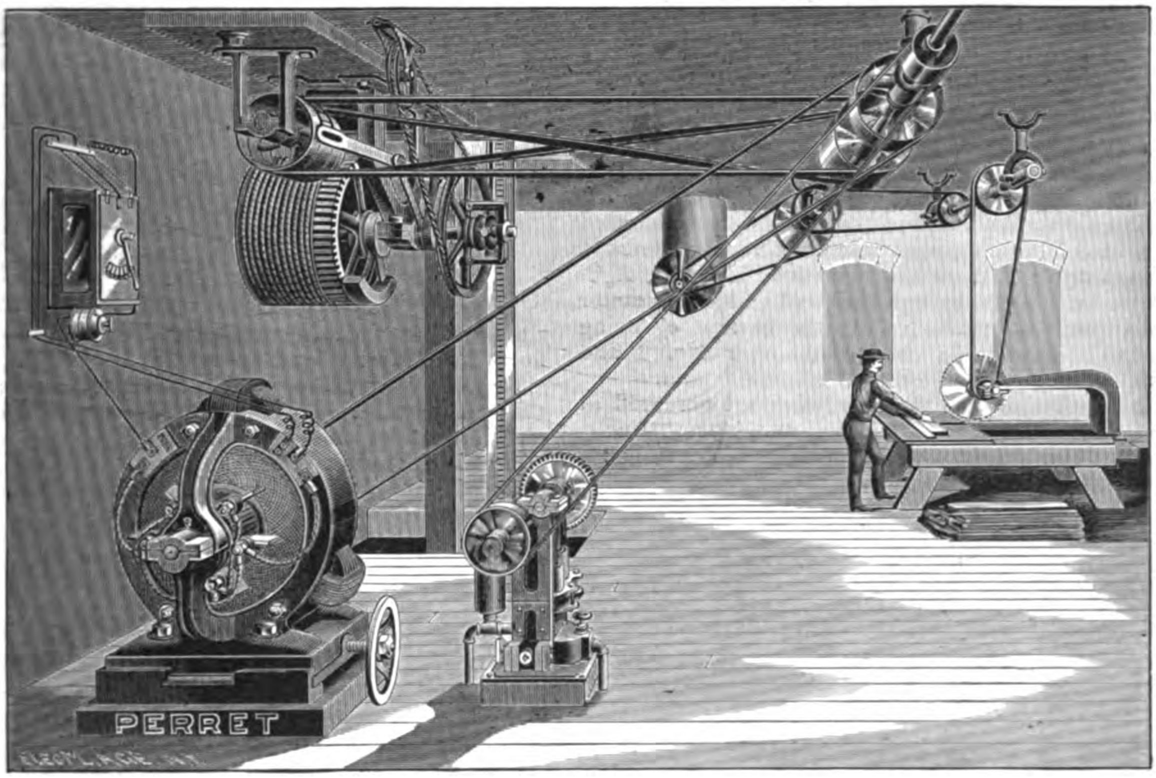
but pray, wait a moment; you have missed the point. I am not asking you to give up Kapp's formula because it is not logically consistent, but because this logical inconsistency is a radical defect in its practical working. Let me explain.

PERRET ELECTRIC MOTOR IN A WOOD WORKING ESTABLISHMENT.

The numerous advantages possessed by electric motors for supplying power in factories, is resulting in their adoption more and more extensively every year, and as a natural consequence the motors themselves are attaining, almost daily, a greater degree of perfection.

The accompanying illustration shows an interesting power plant installed in the factory of Messrs. Wm. Schwarzwaelder & Co., manufacturers of desks and office fixtures, in this city.

A 10 h. p. Perret electric motor is located in the basement, and runs a pump for raising water to the roof, a fan, a circular saw, and two elevators, only one of which is shown.



Perret Electric Motor Plant in a Woodworking Establishment.

The motor is equipped with the Perret self-feeding carbon brushes and self-oiling bearings, and is run at a speed of 600 revolutions by the current from the Edison Pearl street station. It has been in operation four months, giving entire satisfaction, and has required very little attention, the bearings being oiled but once a week, and the brushes, thus far, having been untouched. It runs without sparking and the commutator is as smooth now as when first put in.

The fact that the electric motor occupies much less space than any other class of machine of equal power is thoroughly appreciated by the users, as well as the fact that the fire risk is largely reduced, with a consequent reduction in premiums.

Jamestown, N. Y.—The Jamestown Electric Light & Power Company has elected Charles H. Tew, secretary and treasurer, vice James L. Weeks, resigned.

THE MAGNETIZATION OF IRON BY THE LEYDEN JAR DISCHARGE.

The magnetizing power of a Leyden jar discharge, although a somewhat complex quantity, depends for one thing on its duration. Thus, if a Leyden jar is successively given two equal charges, and in one case discharged very suddenly and in the other comparatively slowly, the magnetizing effect of the latter discharge will probably be greater than that of the former. This is due to the fact that the more rapid discharge produces more powerful superficial eddy currents which effectually shield the interior portions of the bar to be magnetized. The following experiment of M. A. Marianini, which was described in a recent number of the *Nuovo Cimento*, bears on this point. In the discharge circuit of a condenser M. Marianini placed an air gap and a magnetizing helix. The iron to be magnetized consisted of a glass tube filled with iron filings. He observed the deviations of a magnetometer needle, due to the presence of the iron filing cylinder, after the iron had been subjected to various discharges. The air gap was at first ½mm., and after passing ten discharges the needle only deviated by 4 deg. With a sparking distance of 3 mm., four successive discharges resulted in a magnetization strong enough to cause the needle to deviate 32° 30′. With a 7mm. gap, and after only one discharge, there was a deviation of 53° 30′. The same air gap was then used, but the resistance of the circuit was this time increased by introducing a tube containing water; deviations of 77° 30′ and 79° were then attained.

The Aransas Pass Electric Light and Power Co., of Aransas Pass, Texas, which only a few months ago started up a plant of 500 alternating current incandescent lights, has already made the experience that electric light is what the people want and that they will have it. Hence the company has also added an arc light plant to its central station. The apparatus operated is of the alternating current system of the Westinghouse Electric and Mfg. Company, of Pittsburgh, Pa.

DETERMINATION OF THE SHIFTING OF PHASE BETWEEN TWO ALTERNATING CURRENTS OF THE SAME PERIOD.

BY

Chas. Steinmetz.

THE simplest way to determine the angle of difference of phase, existing between two alternating currents of the same period, is to send one current through the movable and the other current through the fixed coil of an electrodynamometer. Then the reading of this electrodynamometer, divided by the product of the strength of both currents, gives the cosine of the angle of difference of phase between both currents.

Let the shifting of phase = angle ω.

" " strength of the respective currents = c' and c''.

Then the reading of the electrodynamometer, when one current flows through the fixed, and the other through the movable coil, is:

$$K = c'\,c''\cos\omega,$$ as is well known.

$$\text{Therefore, } \cos\omega = \frac{K}{c'\,c''}.$$

This value can be positive when angle ω is less than 90°, or less than ¼ of a period; or negative, when angle ω is larger than 90°, or greater than ¼ of a period.

Such a determination will most conveniently be carried out by the use of three electrodynamometer–ammeters.

Let the constants of these instruments = K_1^2, K_2^2, K_3^2.

The current c' is sent through the fixed coil of ammeter No. 1 and through ammeter No. 2; the current c'' being sent through the movable coil of ammeter No. 1 and through ammeter No. 3.

Then the deflections of the ammeters are observed = $\varphi_1, \varphi_2, \varphi_3$.

The current c' is determined by ammeter No. 2 to be:

$$c'^2 = K_2^2\,\varphi_2;$$

the current c'' by ammeter No. 3:

$$c''^2 = K_3^2\,\varphi_3.$$

Ammeter No. 1 reads the value of the resulting force of both currents, which is either positive, for angle $\omega < 90°$, or negative, for $\omega > 90°$.

$$c'\,c''\cos\omega = K_1^2\,\varphi_1;$$

$$\text{and therefrom, } \cos\omega = \frac{K_1^2}{K_2\,K_3}\;\frac{\varphi_1}{\sqrt{\varphi_2\,\varphi_3}}.$$

A number of applications of this method suggest themselves; for instance, for determiningt he difference of current–phase as compared with the E. M. F. Then the voltmeter or shunt current is sent through the fine wire coil of the electrodynamometer–wattmeter, this being used as a part of the additional voltmeter resistance, and the main current sent through the ammeter and the coarse coil of the wattmeter. Then the watts, read by the wattmeter, divided by the product of the amperes by the volts—the voltmeter being supposed to have no appreciable self-induction—gives again the cosine of shifting of phase.

For instance we may have the following readings:

508 watts; 36.8 amperes; 53.6 volts.

$$\text{Therefore, } \cos\omega = \frac{508}{36.8 \times 53.6} = .258;\ \text{angle } \omega = 75°.$$

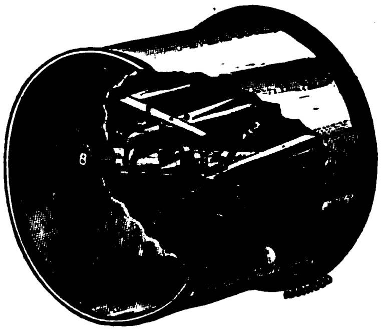
In the same way, by the use of shunt currents and electrodynamometer–voltmeters, the difference of phase between the E. M. F.'s may be measured.

NEW YORK CITY.—The Anglo-American Electric Light Manufacturing Company will hold its annual meeting in the *Times* Building on February 11th, at 2 o'clock. E. H. Sentenne is president and M. Brown, secretary.

NEW CUT-OUT FOR GAS LIGHTING BATTERIES.

GAS lighting circuits are so liable to short-circuiting that some device is necessary to protect the open circuit batteries employed for that class of work. A simple and effective cut-out designed for this purpose has recently been brought out by the Electrical Supply Co., of Syracuse, N. Y.

The cut-out which is shown in the accompanying engraving consists of three independent parts, viz.: An armature; a yoke, A, bearing a counterweight, C, and a tube which is heavier at the end, B, and is half full of a sluggish fluid. This tube may be of metal or glass, as desired. The operation will now be readily understood. When attracted, the armature pushes down the yoke, A, letting the tube tilt a trifle; the fluid begins to flow slowly toward B. After awhile the shifted weight of the flowing liquid tilts the tube and yoke still more until the tube rests against the stiff contact spring, E. The fluid then flows much faster and presently its weight forces the spring away from the insulated contact screw, D, cutting out the battery. To complete the above operation the circuit must be closed for about thirty seconds. If the circuit is cleared before that period the counter-weighted yoke will restore the tube and the fluid will flow back to its normal position. No effect is produced on the instrument by lighting the gas.



NEW GAS LIGHTING BATTERY CUT-OFF.

PLATINUM RESIDUES.

IN the face of the present high price of platinum, says the *Chemical Trade Journal*, residues and "washes" of this metal are well worth working up. The old developing baths for platinotype paper, odd bits of the paper itself, spoilt prints, etc., all may be reworked. Old developers may be treated with saturated solution of sulphate of iron—one part of the saturated solution to four parts of the developer will be about right. The mixture should be heated to boiling in a porcelain dish, and the precipitated metal collected on a filter. Bad prints, clippings, etc., of the paper should be placed on a tin or iron plate and burnt, the ashes collected and digested for some hours at 50-70° C. with *aqua regia*, and then the solution diluted with an equal volume of water, and the platinum precipitated with iron as above, or with ammonium, or formate of soda, or any other reducing agent.

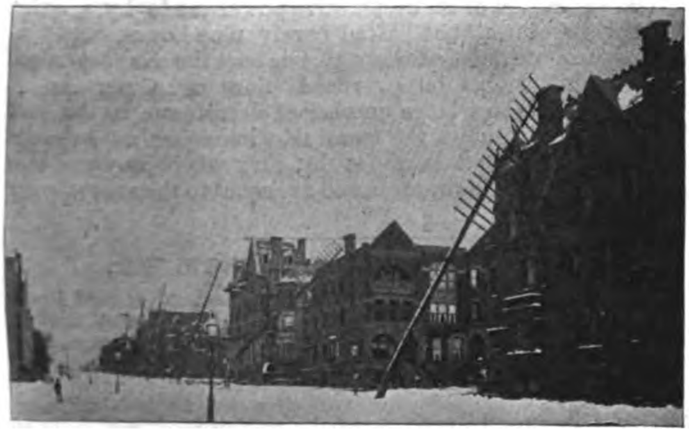
EDISON CO., OF PHILADELPHIA.—The annual report of the Edison Electric Light Company, of Philadelphia, shows that during the past year the company earned $190,000 in gross receipts. It expended $121,000. In order to increase the earning power of the company an issue of $300,000 debenture bonds was determined upon by the directors, and as a result a five-year non-interest-bearing note for $30,000 appears against the year's profits. This note was executed and delivered to the Edison General Company in lieu of royalty.

THE STORM: OVERHEAD WIRES AS A PERMANENT INVESTMENT,

BY

S.S. Wheeler.

The wet snowstorm that visited the Eastern States on the morning of January 25, left its most distinctive traces of destruction and disfigurement in this city. A few hours of heavy snow falling very quietly sufficed to do infinitely more damage to the wires in New York than was accomplished in all the long howling hours of the fierce blizzard of 1888. Last week, but for the subway work that has already been done under the supervision of the Board of Electrical Control, the electric services of all New York would have suffered utter and prolonged paralysis. As it was, the cost of repairs and renewals will run up to not less than $250,000 on a very conservative estimate; and when we emerge from the trouble and all its inconveniences, dangers and delays, the problem of putting every wire underground in this city will have made a great step towards solution.

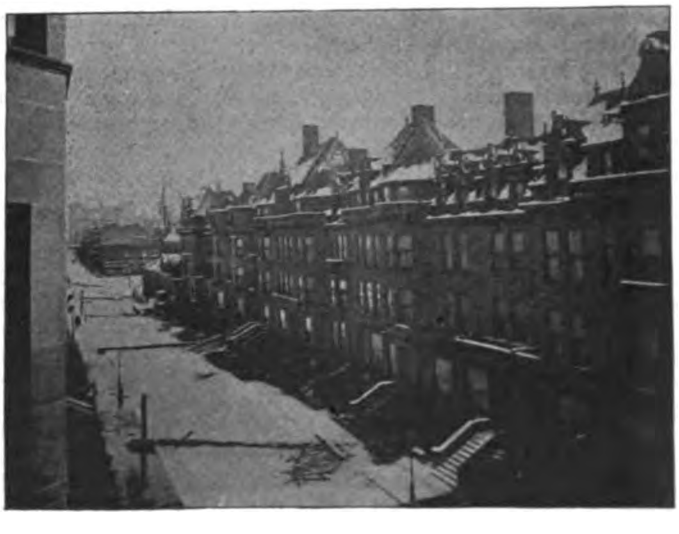


View of West End Avenue Showing Collapsed Telephone Line.
(From a photograph by Mr. E. W. Little.)

The collapse of the wires presents many curious and suggestive features. Three views, selected from a great number, are shown herewith. Some of the finest line construction in the world went by the board in an hour or two, and wonder has been expressed that such solid, substantial poles as those running through the uptown regions with telephone wires, should succumb like so much fragile "grissini." But a simple calculation will furnish the explanation. The snow as it fell and clung to the wire, fanned out beneath until each wire soon looked like a three cornered ruler slightly rounded, the wire forming the upper edge. Each foot of that wet snow weighed about one pound. If we take a pole carrying 170 wires, as many did, and allow it the strain of only 100 feet between poles, it will be seen that the extra weight thus suddenly thrown on, not allowing for the natural strain on the wire, was not less than 8½ tons per pole, applied at the height from the ground of 80 or 90 feet. Nothing but the massiveness of the poles and the excellent quality of the construction enabled them to stand as they did. When they went, however, one followed the other like the proverbial pack of cards.

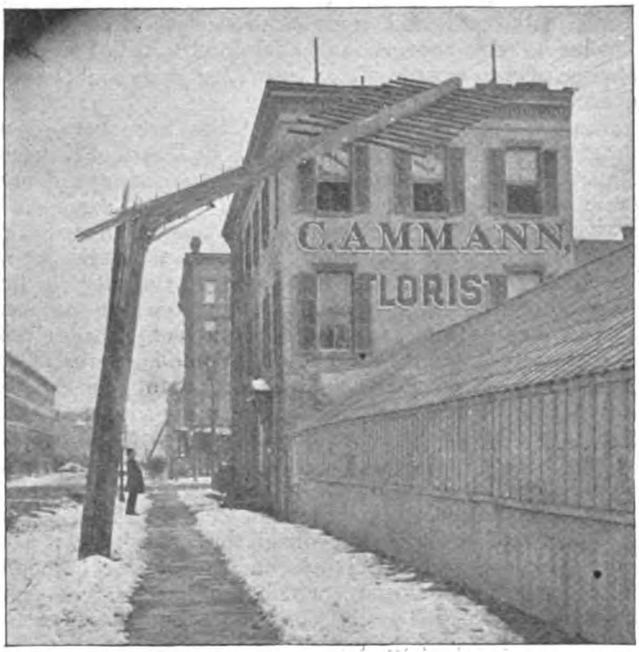
Another striking feature was the variation in the manner of break-down. I have been asked, whether, in the case of a pole line falling, the poles were usually broken or simply uprooted. Having made a special study of that point during the storm, I found that about two-thirds of the poles to succumb were broken, and that about one-third were uprooted. For the latter occurrence there is no excuse. It is easy enough to set the poles deeper. These uprooted ones were earthed only three or four feet. Many of these however were partly broken or ready to break, showing that this setting is about equal in stength to the strength of the poles. They should therefore always be set much deeper. In all the best construction now, such as the long distance telephone line, the poles are set to a depth of 8 or 9 feet, and in new soil even deeper. Evidently the uprooted poles, three feet deep in the ground, could only stand the strain of the pole itself, no allowance being made for the strain of what it had to carry. The uprooted poles represent an old and reprehensible style of construction that meets with no sanction to-day, and that not even the absence of public supervision in earlier years could warrant or excuse.

One method of construction that has been carried out under the direction and approval of the Board of Electrical Control, pending the completion of all the subways planned, came through the terrible ordeal most successfully. Hitherto it has been the practice to place the electric light wires bottom of all, although they are the strongest and least liable to break. On First avenue, the electric light circuits of the Manhattan Company have been put away up above everything, at a height of 80 feet. These circuits consist of 40 single cables, containing one heavy conductor each. The cross arms are braced with stout iron brackets and the poles are carefully cross-guyed with each other. The guys start about 8 feet from the base of the one pole and are secured at about the same distance down from the top of the next, so as to take the strain from the pole at about the same point as that at which it is applied, and thus prevent bending. The insulators are placed well out from the poles to clear the guys, and to leave a "man hole" between the wires through which the lineman can easily and safely get at his work. That pole line stood without a scratch. None of the circuits came down. Below them the storm played havoc with the telephone and telegraph wires crossing at right angle; but they merely dropped to the street without the risk of short circuiting any electric light current. It may be added that, as a general thing, the electric light circuits all over the city had very little damage inflicted on them by the storm directly, and the work on them consisted entirely of clearing them of debris, whose presence required that they should remain inoperative until quite free. The slowest to get clear has been that on Seventh avenue, where a wholesale sweep was made by the falling telephone line between Fifty-eighth and Thirty-fourth streets.



A Prostrate Telephone Pole Line in West Seventy-Third Street, N. Y.
(From a photograph by Mr. E. W. Little.)

The collapse of the telephone line just referred to is rather interesting. It started at a pole up which went a subway terminal pipe. The guy stop across the street had been cut away by the Bureau of Incumbrances, and consequently, when this extra weight came on it, over went the pole, there being nothing to counterbalance it, and it and all its fellows fell in succession, raking south. Had that pole also been cross guyed it would have stood. Another telephone line without guys was that on Park avenue, where the poles fell to the east, and in orienting themselves the whole length of the avenue from 59th to 125th streets, smashed the iron railings around the open spaces of the steam railroad beneath.



Broken Telephone Pole, West 120th Street, N. Y.
From a photograph by Inspector F. E. Brown, of the Board of Electrical Control.)

The Metropolitan Telephone Company, upon whom the heaviest blow fell—3,897 subscribers being disconnected—are more than confirmed by the storm in their intention to get every wire underground as quickly as possible. Even where the incompleteness of the subway system might allow them to rebuild, they will not attempt it, feeling that the permanence of the old overhead system is not great enough. Thus, the Fourth avenue line, now down from Fifty-ninth to Harlem, they will abandon entirely. On Thirty-ninth street from Sixth to Eleventh avenue they will also abandon the entire line. Part of this, from Sixth to Eighth avenue, is replaced by a subway just about ready for occupation, and they will go into that. From Eighth to Eleventh avenue, where there will in all probability be overhead lines for some years to come, they will try to go on the housetops if possible. If not, they will ask permission to put up small, light poles, similar to the electric light poles ; and in any event, instead of stringing individual wires, they will put up cables each carrying 50 or 100 wires, and distribute by means of cable boxes. These cables are not likely to collect snow and ice, and if they fall will do so only a short distance and will not make a tangle of wire. In other words, the plan means the applying of subway methods to overhead construction until in due time the subway is ready, when the same cables can be readily transferred to it if sound.

The somewhat celebrated West End Avenue (Long Distance) line will not be replaced, but instead of spoiling a fine residential district, the same circuits will be taken through Sixty-sixth street to Tenth avenue—a region of gas works—and thence run out. This magnificent line will be well remembered by those members of the National Telephone Exchange Association who inspected it from the tops of stages at the invitation of the Telephone Co., during the convention in this city two years ago. The wires of the Thirty-eighth street Exchange, which suffered very severely owing to the preponderance of overhead lines in its network, will be at once connected up with the terminals of the new subway work, and thus its service will very soon be largely an underground one.

The loss of the local and long distance telephone companies is enormous, and connot be put at less than $150,000 to $200,000, a heavy loss for even rich corporations. The telegraph companies came off pretty well, though beyond the city limits they felt the full brunt of the storm. I am informed that the Western Union had as many as 1,600 poles down between Jersey City and Wilmington, Del. In our Annexed District, the Postal Telegraph Co. had a whole pole line wiped out. The fire and police services were both sorely crippled, and even now can hardly be said to have recovered their full efficiency.

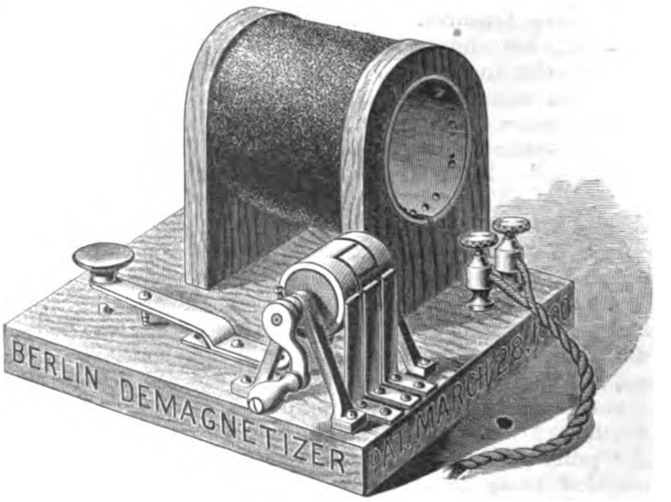
The exhibition of its destructive power made by a quiet little snow storm that lasted barely nine hours, ought to suggest in interested quarters throughout the country some weighty reflections on overhead lines as a permanent investment where a large number of circuits are to be run together, and to point the moral that imperfect as subway systems and methods may yet be, they alone answer the requirements of the situation and are equal to the emergency in a great city.

A SIMPLE WATCH DEMAGNETIZER.

The general adoption of electricity to the comforts and luxuries of life, in the home, the workshop, on the street cars, and in fact everywhere, while bringing its manifold advantages and blessings, at the same time creates a condition of things relative to our watches which did not heretofore exist.

Wherever a dynamo machine is in operation, there is more or less stray magnetism, and a watch happening in this vicinity is quite liable to become magnetized, being thereby rendered worthless as a time-piece until deprived of its magnetism. Consequently, any contrivance which will make it a simple matter to demagnetize a watch will be considered useful to all central station and electric railway men, and if such a device were placed in each station or power house, a large "demagnetizing business" would soon develop.

The accompanying engraving shows the Berlin "Demagnetizer," a simple machine devised for this purpose. The instrument can be used with either a constant or an alternating current circuit. If only the former current is at hand, the small crank attached to a pole changing commutator is revolved, thus causing the current passing through the coil to become alternating, with the consequent effect of neutralizing any magnetic body passing through it. Of course, if connected to an alternating circuit, the pole-reversing attachment need not be used.



The "Berlin" Watch Demagnetizer.

The watch is passed through the centre of the coil, then removed very slowly, being kept in a straight line with the centre, until entirely removed from the magnetic field. The constantly decreasing field of alternating polarity acting on the watch, deprives it of all magnetism. The instrument is manufactured by the Berlin Demagnetizing Co. of this city.

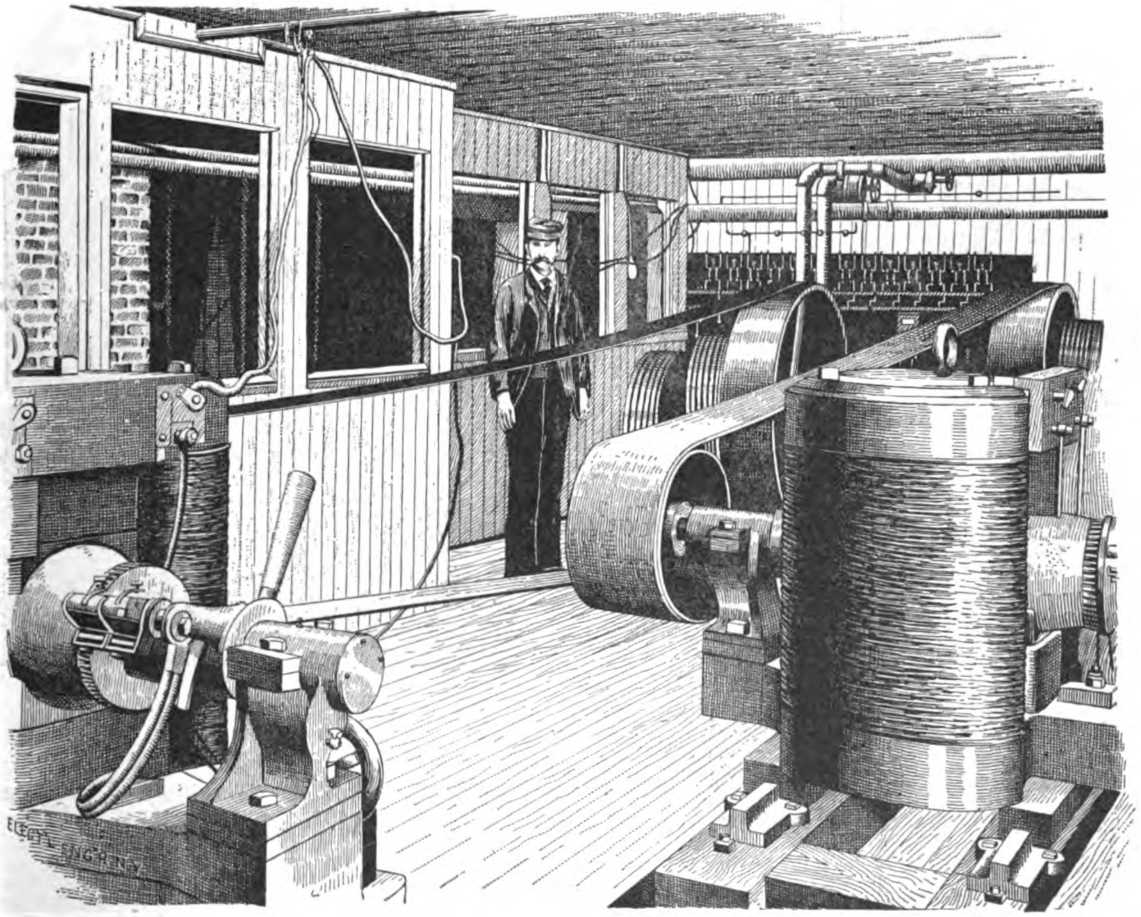
THE LOOMIS PLANT, MANHATTAN AND MERCHANTS' BANK BUILDING, N. Y.

BY

McSullivan.

It is a rare exception at the present time to find an office building erected that does not include, among its appointments, an electric light plant. These installations, with their high-class machinery and novel details, rarely fail to be of interest.

A model plant of this kind has lately been installed in the Manhattan and Merchants' Bank building, 40 and 42 Wall street, this city, by the Eureka Electric Co. It consists of two 400-light Loomis compound-wound automatic dynamos. The winding of these dynamos is such that it does not matter whether the whole number of lamps are in circuit or not, the potential remaining constant; and this is quite a valuable feature in an office building, where the lamps are turned on and off indiscriminately, thus varying the load, and should the dynamo be unable to take care of itself it would require constant attention. Consequently, the life of the lamps is materially increased.



Loomis Incandescent Plant, Manhattan and Merchants' Building, N. Y. City.

The dynamos are driven by two Beck engines of 60 h. p. each, connected to the dynamos by double leather belts.

The building is wired for 1,000 lights, the Grimshaw White Core being used throughout. A separate feeder is run from the dynamo room in the basement to each of the ten floors, and are connected on the switch-board to the bus bars by double pole jaw switches.

A separate feeder is run to each of the two banks, and also halls and lavatories.

The switch-board is made of marbleized slate and presents a neat appearance with its brass and copper fittings. It is so arranged that the plant can be divided in two, one dynamo taking half the number of lamps and running them independently; or, by throwing in a plug switch, the bar is made continuous and both machines are thrown into multiple arc. A ground detector is placed on the switchboard, so that should a ground come on the system it will be noticed at once.

The current is carried from the dynamo to the switchboard through copper bars, and each dynamo connects to it from opposite sides.

The entire plant is a most complete one, and shows thorough knowledge on the part of those who had it in charge, of the best methods of construction now in vogue.

THE JAMAICA AND BROOKLYN (L. I.) RAILROAD.

The State Railroad Commission—William E. Rogers, chairman, Isaac V. Baker, Jr., and Michael Rickard—have given a hearing to the application of the Jamaica and Brooklyn Railroad for permission to use electricity as a motive power. The road has been running its cars by the trolley system of overhead wires for two years and desires to continue to do so. The authorities of Brooklyn and Jamaica brought suit against the railroad some time ago to have certain local restrictions imposed. Edward S. Clinch, who appeared as counsel for the company, informed the Commissioners that his client was willing to submit to any reasonable local restrictions.

Representatives of Jamaica and Mr. Clinch agreed:

'That the Jamaica authorities should regulate the rate of speed, the posts should be presentable, the cars should be managed by not less than two men, the induction of electricity from the overhead wires to adjacent wires should be prevented, there should be a protective wire above the road electric wires, and that the company should conform to such reasonable regulations as the local authorities might impose."

THE UNIVERSAL THEATRICAL ARC LAMP.

THE use of the calcium light on the stage is always attended with considerable inconvenience, the cylinders, and pipes necessary for its operation being cumbersome, and the noise and heat annoying. These difficulties are successfully overcome by the use of the theatrical arc lamp, shown in the accompanying engravings, and made by the Universal Arc Lamp Co., of this city.

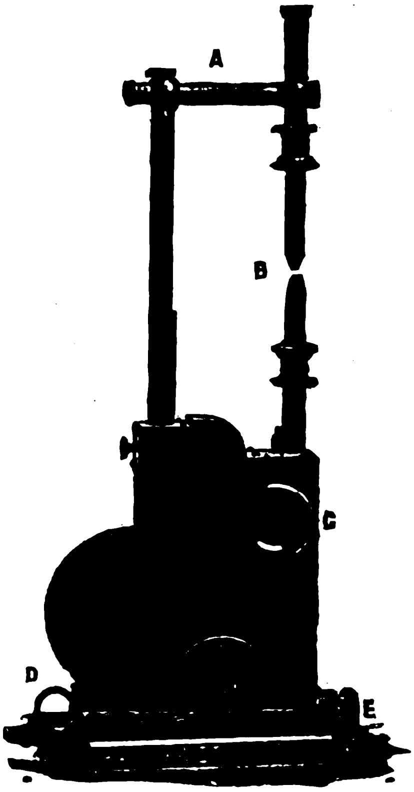


FIG. 1.—THE UNIVERSAL THEATRICAL ARC LAMP.

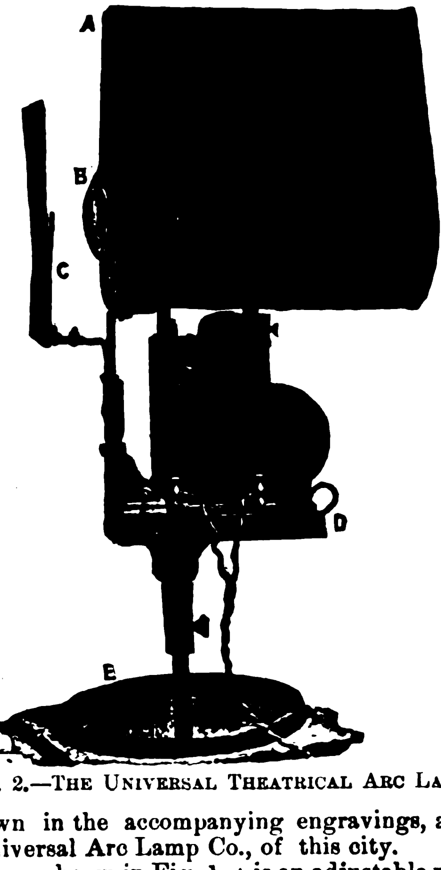


FIG. 2.—THE UNIVERSAL THEATRICAL ARC LAMP.

In the lamp shown in Fig. 1, A is an adjustable rod to hold the upper carbon. C is the feeding screw and D, the handle for adjusting the focus. By means of the handwheel E, the adjustment of the relative carbon feed is effected. The intensity of the light can be varied from 100 to 10,000 c. p., and the lamp, operating at only 45 volts, is perfectly safe to handle.

Fig. 2 shows the lamp mounted on a stand and resting on the iron cradle D. A and B show the lens box and lens, respectively, and C, a small color holder.

In Fig. 3, A is a small reflector and C the plug for connecting the lamp with the resistance box by means of the socket, D; J being the stand adjustment screw.

To avoid the possibility of making a wrong connection, the plug and socket, C and D, are made V-shape.

Besides doing the work of the calcium light, this lamp can be used in producing many novel and striking effects, such as the natural rainbow, illuminated fountain, morning clouds, thunder-clouds, chain lightning, and others.

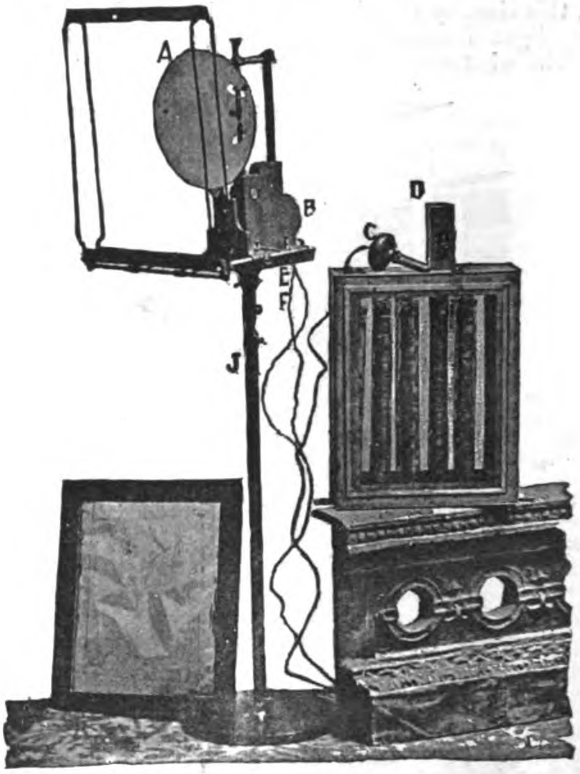


FIG. 3.—THE UNIVERSAL THEATRICAL ARC LAMP.

MR. JAMES ENGLISH has taken up the controversy on municipal lighting at New Haven, Conn., and, in the newspapers there, has brought forward a variety of figures going to show how incomplete and inaccurate are the statistics which have been published to show that municipal lighting is cheaper for a community than that which it pays for under contract with a private corporation. The cause of this controversy is an address made by Mayor Sargent before the Trades Council favoring municipal ownership.

MUNICIPAL ELECTRIC LIGHTING.—In calling attention to a bill introduced in the Pennsylvania Legislature allowing municipalities to go into the business of electric lighting, the *Oil City Derrick* says it intends to offer a strenuous objection to the passage of general legislation of this sort. It says that as a result of such indiscriminate venturing upon business enterprises, the bonds of Ohio municipalities are a cheap and over abundant article, and the average Ohio town and city is head over heels in debt. Moreover, city operation of electric plants has not yet been demonstrated to be a success, and "judging from experience of muncipal control in other lines, it never will be."

MR. DAVID BROOKS has offered to the city of Philadelphia the free use of his underground system, with which, he claims, a 3-inch pipe carrying 500 conductors can be laid at a cost of $1600 per mile.

NEW THOMSON-HOUSTON SINGLE REDUCTION CAR GEAR.[1]

FOR about a year past it has been an open secret that the Thomson-Houston Electric Co. were experimenting with a new slow speed motor for street railway service, but not till the present, after long and severe tests, have they felt justified in putting it upon the market. This new machine has been named the S. R. G. motor.

The photographs from which our engravings were produced we obtained on a recent visit to Boston and Lynn where we had the privilege of inspecting the S. R. G. motor, studying the details of its manufacture, and also of a ride on a West End car (No. 120) equipped with two of these machines. The operation of the gear is practically noiseless, and the tests show that the motor is more powerful in driving the car than the double reduction high speed motors with the same current.

As will be noted from the illustration, Fig. 1, the motor is nearly iron clad, having two internal pole pieces of ample spread, carrying two field coils which partially surround the armature core, on the same principle as the well-known arc light dynamo originated by Professor Thomson. The magnetic circuit is completed on the front end of the motor by the nose plate, and on the back end by the frame, on which are cast the axle boxes and arms, which serve as a support for the armature shaft bearings, Fig. 2. The armature is of the Gramme ring type, and the bobbins are wound close together around the entire rim, Fig. 3; one great advantage of this construction is the fact that any coil can be easily rewound without disturbing its fellows, while with the drum armature in the type of motor formerly used by the company and still largely used, the winding all had to be renewed down to the injured coil.

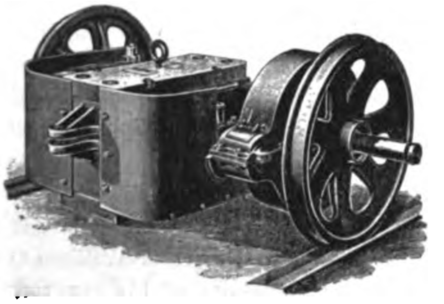


FIG. 4.

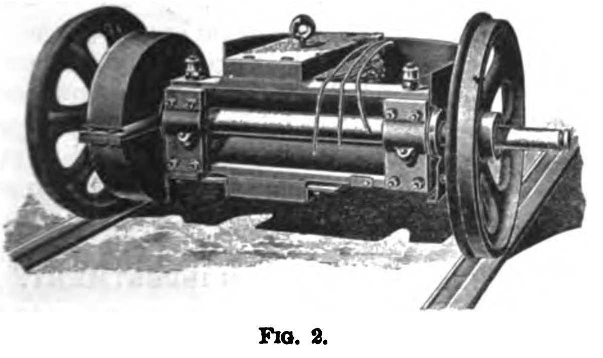


FIG. 2.

The brushes are placed exactly opposite and in a horizontal, fixed position and are easy of access.

The field coils are protected on all sides by the fields and frame. The gears are entirely enclosed in a dust and oil-tight case, which is provided with a handhole closed by a spring cover, Fig. 4, permitting ready examination of gears and the introduction of lubricants. A sheet iron pan, Figs. 2 and 4, extending above the centre of the armature shaft entirely encloses the bottom and sides of the motor and protects the armature and commutator from dust, snow and water. The advantage of this casing was strikingly demonstrated during the recent snow storms, the S. R. G. coming through unscathed while some of the fields on the old style of motor came to grief from the effects of excessive moisture. This pan has a sliding bottom and is attached to the motor in such a manner as to permit of being readily removed for access to the various parts.

The motor when mounted on a truck with thirty-inch wheels is designed to clear the top of the rails four inches, Fig. 5. The spur pinion on the armature shaft is of steel, four and a half inches face, and has fourteen teeth, The split gear which is bolted on the car axle is of cast iron with the same width of face, and has sixty-seven teeth. The speed of the armature shaft relative to that of the car axle is nearly 4.8 to 1, and when the car is running ten miles per hour the armature makes 538 revolutions per minute, or the speed of the armature is 53.8 turns per minute per one mile per hour.

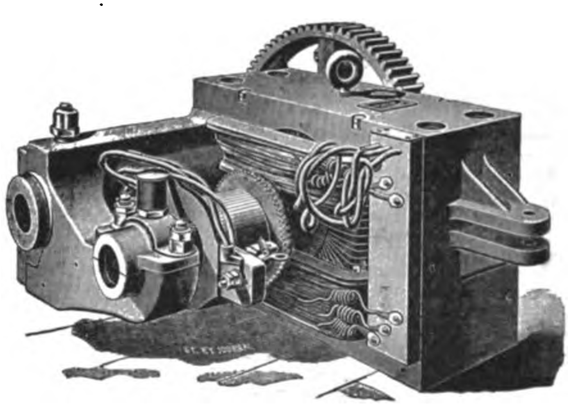


FIG. 1.

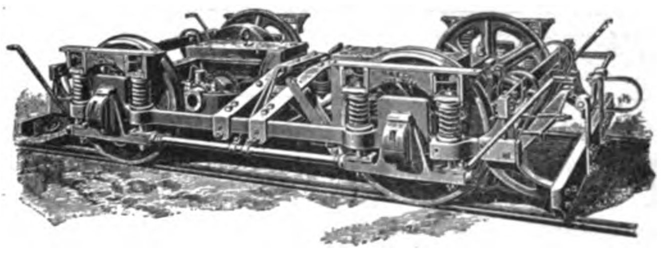


FIG. 5.

The facility with which the armature can be removed simply by lifting the upper field, the ease with which an armature bobbin can be rewound, less liability to damage from centrifugal action, such as bursting of binding wires displacement of coils, breaking of commutator connections, all insure a minimum amount for repairs.

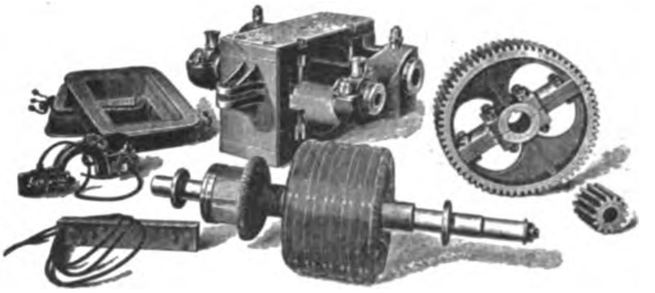


FIG. 3.

The only perceptible sound is the rolling of the car wheels on the rails. The grating of the gears and fretting of the commutator bars against the brushes, so offensive with the old type of motor at high speed, is eliminated.

The new machine having practically an iron clad magnetic field, avoids the liability to short circuit, common to motors supported by a nose plate.

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[1] *Street Railway Journal*, Feb., 1891.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XI. NEW YORK, FEBRUARY 4, 1891. No. 144

The inventor to secure his success, must consult the discoverer, and the practical skill of one be directed by the theoretical knowledge of the other.—Joseph Henry.

A CENTURY OF THE AMERICAN PATENT SYSTEM.

IT is proposed, and all the preliminary arrangements have now been completed for the purpose, to celebrate next April in Washington the completion of the first century of the American patent system. In connection with the meeting then held, it is also intended to organize a National Association of Inventors. Both ideas are excellent, and the programme issued privately in advance indicates that the greatest interest is taken in the matter by influential and representative men. Not only will the special sessions be presided over by President Harrison, Secretary Noble and Prof. Langley, but the papers to be read at the regular meetings will be the production of distinguished judges, economists, statisticians, publicists and engineers, and will deal with every phase of the patent system ~~and~~ its effect upon society.

Such an occasion as this will be a most favorable one for impressing upon the public mind the enormous benefits that the system has conferred upon American civilization and development. Strange as it may seem, there are not a few opponents of our present liberal patent law, and not a few who are so ignorant of its principles as to characterize the ownership of a valuable patent as a "gigantic monopoly." If we wish to stop the present rapid rate of advance in the arts and sciences, in general welfare and individual comfort, all that is necessary is to abandon the system; and the convention will do a great service if it have no other result than enlightening the public as to the manner in which our patent laws, while rewarding the successful inventor, confer incalculable benefits at the same time upon society at large. The system is not perfect—far from it—but it is one of the most useful and praiseworthy of our institutions, unsurpassed as a creator of property and values, and of blessings common to all.

One reform the convention should insist on, and that is that the Patent Office shall at least be decently housed. In our columns this week will be found a letter from a well-known public man, who, visiting the Office only a few days ago, was horrified and disgusted with the conditions of things there. Yet it has even been contemplated to make matters worse by more crowding and by filling up the interior court with another building, so that the supply of light and air already so inadequate will be still further reduced. The convention must make a firm demand, admitting of no refusal, that a part of the large surplus now to the credit of the Patent Office shall be spent in the extension of its facilities, either in its old home or in a new one. And while it is about it, and is putting a hand to practical reforms, the convention might as well ask that the staff of the Office shall be paid higher salaries, more commensurate with the quality and quantity of the work done.

CROOKES ON RADIANT MATTER.

SOME twenty years ago Professor William Crookes first gave to the world the results of his experiments on the state of matter in high vacua. The scientific world was dazzled, and justly so, by their brilliancy and by the power of the reasoning brought forward to explain their action. Radiant matter has since then remained the subject of discussion from time to time, but thus far the hopes, at one time expressed, of the practical utilization of the phenomena involved have not been realized. In his inaugural address before the London Institution of Electrical Engineers, Prof. Crookes rapidly reviews these phenomena and adds a few new ones to those already known, accompanied by a discussion in the light of his most recent researches. These cannot fail to call attention again prominently to what we believe must eventually lead to results of the highest practical importance. True, it would be difficult to point out in the present state of our knowledge the exact path to pursue in obtaining these practical results, but the problem of obtaining light without heat is now one of such immediate moment and the pecuniary reward consequent upon a successful solution of the problem is so great, that the energies of inventors can be bent in no more hopeful direction than this.

OVERHEAD WIRES AS AN INVESTMENT.

THE late snowstorm with its wholesale destruction of pole lines throughout this city had many lessons, and in the very interesting article by Dr. S. S. Wheeler, the Subway Board's expert, they will be found in brief summing up and explanation. In order to give an exact idea of the damage inflicted on adjoining houses, we have made two or three reproductions from photographs kindly furnished us. It is evident, however, both from the article and the illustrations that in an episode of this kind the companies suffer rather than the public. To read the daily papers, one would think that the snapping of a single wire meant death to thousands of citizens; but here we have the breakdown of thousands of wires and hundreds of poles without a single fatality. Dr. Wheeler hits the nail on the head in the title to his article, suggesting that as a matter of finance and management, overhead wires are too costly to be looked upon as a permanent investment, if they are thus to be blown out of existence or broken down by snow every other year. It will be gathered from what he says that subway work will be appreciably expedited by the late storm, and that such overhead construction as remains will be much improved. It is one cause of satisfaction that the maligned electric light circuits were those least affected by the storm, and that where better methods of construction had been resorted to, their behavior left nothing to be desired.

THOMSON-HOUSTON SINGLE-REDUCTION CAR GEAR.

We have on more than one occasion referred to the fact that the present tendency in electric railway work leans towards the reduction of the number of gears employed in transmitting the power from the armature shaft to the car axle. We have also described quite a number of devices designed, for this purpose. It is significant, therefore, to note the undoubted influence which the new idea is obtaining in the methods of work of one of the largest companies in the field. The new departure by the Thomson-Houston Company, illustrated this week in our columns, will, without doubt, have considerable influence on the future methods employed and is another evidence of the progressive nature of electric railroading. The high-speed electric motor on the electric car has done, and is doing, excellent service, and the change to the present style is not to be looked upon in any way as a setback to the high-speed motor *per se*, but rather as a recognition of the fact that every additional link in power transmission necessarily involves a loss in power as well as other inconveniences which it is desirable to avoid as far as possible.

THE WORK OF THOMAS DAVENPORT.

When Moses went up from the weary plains of Moab to the top of Pisgah and viewed afar the promised land as it lay below with green valleys and well watered pastures and waving palm trees, he was but the type of the leaders in many another and later field of work. They have been the pioneers; they have borne the burden and heat of the day; they have grown old and wornout in devotion to duty; and then, when the end is reached to which their efforts alone have conducted, they do not enter in.

There may, after all, be some compensation in this, as in most cheatings of hope, and part of this compensation doubtless lies in the fact that it saves from even greater disappointment than is actually endured; while the fact remains, clear to admiring posterity, that whatever was possible at the time was accomplished. Herein is the victory, and not in the mere handling and enjoying of materialities that would of themselves be but poor stimulus or solace to the aspiring spirit of high purpose or lofty genius.

As we read, therefore, the last page of Mr. Pope's fascinating chapters on the work of the Vermont blacksmith, we realize, though Davenport did not, that he had then traveled as far as could be gone along the road of discovery that in later years has brought us to the grand utilization of electricty as a motive power. The modern motor existed in his mind and was roughly shaped by his hands, and he died with the belief that in carrying out his ideas to the full he would have settled the whole problem. But dissolving zinc would never stand the competition of burning coal, and hence, failing a better source of current than the primary battery, Davenport would have been doomed to even sharper disappointment than was in reality his lot. It is curious to note how with that remarkable instinct of the intellect which knows what is lying beyond the difficulties, he said that any idea of limitation in the size of an electric motor affected him with "peculiar disagreeableness." To-day, with huge dynamos as a central source of current, he could build his motor any size he wished, and none would say him nay.

Mr. Pope is entitled to very hearty thanks and praise for the pains and skill with which he has written this life of a truly noble man and paid a richly deserved tribute to the first American inventor of the electric motor.

THE "HENRY."

In the early days of modern dynamo construction much of the work, if not all, was accomplished by the application of empirical rules and it was not until the true theory of the dynamo and of the relation of the magnetic and electric circuits was brought out that dynamo designing may be said to have been reduced to a science. The alternating current dynamo, and alternating apparatus generally, have passed and are passing through much the same change, but in the latter a factor, present in the continuous current apparatus to a perceptible degree, springs at once into the greatest prominence, namely, self-induction, and must be considered accordingly. The basis of the calculation of alternating current apparatus must, therefore, be referred to some unit. Such a unit was adopted by the Paris congress and termed the "quadrant." A short while ago Prof. F. B. Crocker very properly suggested the propriety of naming this unit the "henry," and mainly through his labors in connection with the Committee of the American Institute of Electrical Engineers appointed for that purpose, the henry has now been adopted as the practical unit of self-induction and has already secured a firm place in electrical literature. The discussion on this unit which took place at a recent meeting of the Institute, would seem, on the surface, to lead to the opinion that the various definitions of which the unit is susceptible might lead to considerable uncertainty in practice; but we cannot doubt that, as time passes and a better insight is gained by a large majority of working electricians into the true nature of the unit, this apparent disparity will disappear. If, as one of the speakers pointed out, the conditions under which each experiment is effected be known, there ought to be no difficulty in reducing the results to a common basis of comparison. The adoption by the Institute of the henry as the practical unit will, we are certain, give the unit a firm standing among engineers. This is already evidenced by the fact that the Society of Civil Engineers has adopted it, which action, without doubt, will be followed by other societies throughout the country, and we hope, abroad.

ELECTRICITY IN TRANSITU: FROM PLENUM TO VACUUM.[1]

BY WILLIAM CROOKES, F. R. S.

IN submitting to you certain researches in which electricity is used as a tool, or as a means of bringing within scope of our senses phenomena that otherwise would be unrevealed, I must for a moment recall to your minds the now generally accepted theory of the constitution of matter.

KINETIC THEORY OF GASES.

Matter, at its ultimate degree of extension, is conjectured to be not continuous, but granular. With speculations as to the constitution of liquid and solid matter I need not trouble you, but will proceed at once to the third or gaseous state of matter.

The kinetic theory of gases teaches that the constituent molecules dart in every possible direction with great but continually varying velocities, coming almost ceaselessly in mutual collision with each other. The distance each molecule traverses without hitting another molecule is known as its *free path*; the average distance traversed without collision by the whole number of molecules of a gas at any given pressure and temperature is called the *mean free path.*

When the mean free path becomes comparable to the dimensions of the containing vessel, the attributes which constitute gaseity shrink to a minimum, the matter attains the ultra-gaseous or "radiant" state, and we arrive at a condition where molecular motions under electrical impulse can easily be studied.

The mean free path of the molecules of a gas increases so rapidly with progressive exhaustion, that whilst that of the molecules of air at the ordinary pressure is only $\frac{1}{10000}$th of a millimetre, at an exhaustion of a hundred-millionth of an atmosphere—a point (which, with present appliances, is easy to attain) corresponding to the rarefaction of the air 90 miles above the earth's surface—the mean free path will be about 30ft.; whilst at 200 miles above the earth it will be 10,000,000 miles, and millions of miles out in the depths of space it will become practically infinite. I could go on speculating in spite of Aristotle, who said: "Beyond the universe there are neither space, nor vacuum, nor time."

In discussing the motions of molecules we have to distinguish the *free* path from the *mean free path.* Nothing is yet known of the *absolute* length of the free path nor of the *absolute* velocity of a molecule. For anything we can prove to the contrary, these values may vary almost from zero to infinity. We can deal only with the *mean* free path and the *mean* velocity.

THE VACUUM PUMP.

As most of the experiments I put before you to-night are connected with high vacua, it is not out of place to refer to the pump by means of which these tubes are exhausted. Much has been said lately in recommendation of the Geissler pump and its many improvements, but I am still strongly in favor of the Sprengel, as with it I have obtained greater exhaustion than with any other. I should like to point out that the action does not stop when we cease to see air specks passing down the tubes, but continues long after this point has been passed. Neither is the non-conducting vacuum, so easily obtained by the Sprengel pump, due in any way to the presence of mercury vapor, since non-conduction can be obtained just as rapidly when special precautions have been taken to keep mercury vapor out of the tubes. One of the great advantages of the Sprengel pump over all others lies in the fact that its internal capacity need not exceed a few cubic centimetres, and there is, therefore, much less wall surface for gases to condense upon.

THE PASSAGE OF ELECTRICITY THROUGH RAREFIED GAS.

The various phenomena presented when an induction spark is made to pass through a gas at different degrees of exhaustion point to a modified condition of the matter at the highest exhaustions. Here are three exactly similar bulbs, the electrodes being aluminum balls, and the internal pressures being respectively 75 mm., 2 mm,, and 0.1 mm. If I pass the induction current in succession through the bulbs, you will perceive in each case very different luminous phenomena. Here is a slightly exhausted tube, Fig. 1, like the first in the series just exhibited (75 mm.), the induction spark passes from one end to the other, A B, and the luminous discharge is seen as a line of light, acting as a flexible conductor. Under the tube I have an electromagnet, C, and on making contact the line of light dips in the centre down to the poles of the magnet, and then rising again proceeds in a straight line. On reversing the current the line of light curves upwards. Notice that the action of the magnet in this case is only local.

In a highly exhausted tube the action is quite otherwise. Such a tube is before you, Fig. 2, and in it I have carried the exhaustion to a high point (0.1 mm.). I pass the induction current and you perceive the electrified molecules, like the line of light in the first tube, also move in straight lines, and make their path apparent by impinging on a phosphorescent screen, D E. If, however, I submit them to the action of a magnet, C, their behavior is different. The line dips down to F, but does *not* recover itself.

It seems that in the tube first shown we have to do with the average behavior of the molecules of gas in its totality. In the second case, where the gas has been greatly attenuated, we are merely concerned with the behavior of the individual molecules of which it it was originally composed.

THE STRATIFIED DISCHARGE.

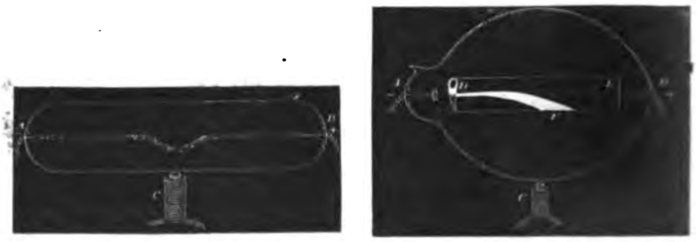
When the gas is rarer than is necessary to give the flexible line of light, as shown in the first experiment, the luminosity is plainly discontinuous, or, as it is termed, stratified.

Suppose we experiment on little particles of some substance, such as sand, approximately equal in size. If we mix the particles with water in a horizontal tube and set them in rhythmical agitation, we shall see the powder sorting itself with regularity into alternate heaps and blank spaces.

If we pass to yet more minute substances we observe the behavior of the molecules of a rarefied gas, when submitted to an induction current. The molecules here are free, of course, from any caprice, and simply follow the law I seek to illustrate, and though originally in a state of rampant disorder, yet under the influence of the electric rhythm they arrange themselves into well-defined groups or stratifications; the luminosities show where arrested motion with concomitant friction occurs, and the dark intervals indicate where the molecules travel with comparatively few collisions.

PARTI-COLORED STRATIFICATIONS.

As another illustration of stratifications in a moderately exhausted tube (P. = 2 mm.), I will take the case of hydrogen prepared from zinc and sulphuric acid after being passed through various purifying agents, dried in the usual manner, and exhausted with a mercury pump, Fig. 3. I pass the induction current, and we see that the stratifications are tri-colored, blue, pink, and grey. Next the negative pole, A, is a luminous layer, then comes a dark interval or Faraday's dark space (see below), and after this are the stratifications, the front component (*b*) of each group blue, the next (*c*) pink, and the third (*d*) grey. The blue discs are somewhat erratic. At a certain stage of exhaustion all the blue components of the stratifications suddenly migrate to the front, forming one bright blue disc, and leaving the pink and grey components by themselves. The tube before you, Fig. 4, is at this particular stage of exhaustion, and on passing the current you observe the blue disc only (*b*) is in front. When the tube contains a compound gaseous residue of this kind, the form of stratifications can be very considerably altered by varying the potential of the discharge. This alteration in the forms of stratification was first pointed out by Gassiot (1865, "B. A. Abstracts," p. 15), who gave very full descriptions and drawings of the alterations produced by putting in resistances of various lengths of distilled water. The alteration depends simply upon the difference of potential.



FIGS. 1 AND 2.

THE DARK SPACE.

After the stratification stage is passed we come to a very curious phenomenon, the so-called "dark space." Studying electrical phenomena in gases, in the year 1838, Faraday pointed out a break in the continuity of the luminous discharge separating the glow of the positive electrode from that of the negative. This he called "the dark space." It is seen in tubes containing gas only slightly rarefied, as in this tube, Fig. 5 (P.=6 mm.), where you will observe that the positive glow, extending as a pink streak from the positive electrode, B, ends about 10 millimetres before the spot of blue light, C, representing the negative glow. This gap, or non-luminous hiatus, D, is Faraday's "dark space." Separating the negative glow from its electrode is another space. In this tube it is so small that the glow appears to be in actual contact with the electrode, but on exhausting a little further it rapidly separates; and in the next tube, Fig. 6, containing air at a little less pressure (P.=8 mm.), this dark space, E, has extended so as to remove the negative glow about four millimetres from the electrode, A. It is with this second dark space that I particularly wish to deal to-night. Therefore I shall refer to it as the "dark space," meaning always that in the negative glow.

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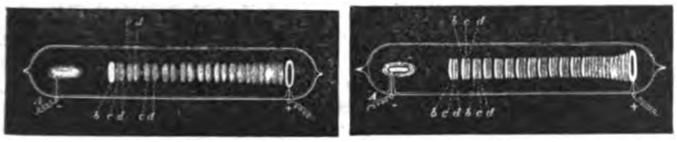
[1] Abstract of presidential address delivered before the London Institution of Electrical Engineers.

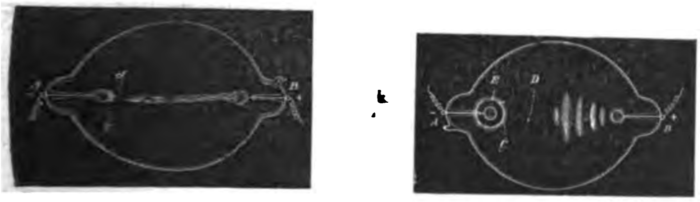


FIGS. 3 AND 4.

In the experiment just shown with hydrogen stratifications the contents of the tube under the electric discharge still obey the laws following from the average properties of an immense number of molecules moving in every direction with velocities of all conceivable magnitudes. But if I continue exhausting, the dark space, E, round the negative pole, A, becomes visible, grows larger and larger, and at last fills up the entire tube. The molecules at this stage are in a condition different from those in a less highly exhausted tube. At low exhaustions they behave as gas in the ordinary sense of the term, but at these high exhaustions, under electric stress, they have become exalted to an *ultra-gaseous* state, in which very decided properties, hitherto masked, come into play.

The radius of the dark space varies with the degree of exhaustion, with the kind of gas in which it has been produced, with *the temperature* of the negative pole, and to a less extent with *the intensity* of the spark.

It has been erroneously assumed that I ever said the thickness of the "dark space" represents the mean free path of the molecules in their ordinary condition, and it has been pointed out that the radius of the dark space is decidedly greater than the calculated mean free path of the molecules. I have taken accurate measurements of the radius of the dark space at different pressures, and compared it with the calculated mean free path of the gaseous molecules at corresponding pressures when not under the influence of electrical energy, and I find that they do not bear a constant relation one to the other. The length of the dark space is not 20 times the mean free pass, as some have estimated, but a gradually increasing multiple must be taken as the exhaustion becomes greater.



FIGS. 5 AND 6.

(*To be Continued.*)

Society and Club Notes.

THE WINTER MEETING OF THE MAGNETIC CLUB.

At Martinelli's, on January 28th, the Magnetic Club held its Winter meeting, beginning with the usual dinner. The new president, Mr. Edward C. Cockey, was in the chair, and the guests of the evening were Mr. A. B. Chandler and Mr. George G. Ward. A very happy little speech was made by Mr. Cockey in acknowledgment of the honor recently conferred upon him, and he expressed his intention of making the meetings more useful and enjoyable than ever. He then introduced Mr. Chandler, who read a brief paper embodying his reminiscences as an operator at Washington, in the War Department, during the the Civil War, when he was brought into frequent and intimate contact with President Lincoln, and enjoyed not a few confidences of that great man during some of the most exciting episodes of the conflict. The paper was heard with breathless attention and at its close, on motion of Mr. C. P. Bruch, who is the son of an old military telegrapher, it was resolved that the paper should be printed by the Club, with the permission and revision of its author. Mr. George G. Ward followed in a very amusing and stimulating extemporaneous address in which he traced his career briefly from the time when he began as an operator at the mature age of seven years, and only two years afterwards was called upon to instruct a stupid ticket and freight agent fifty years old, on one of the English railroads. When, by the reluctant consent of his father, a railway official, he at last entered the telegraphic profession in regular course, he was sent to Egypt and performed his duty through a tremendous epidemic of cholera in Alexandria. Soon after this he became connected with submarine cable work, and thus has been brought to his present high position in connection with the Commercial Cable Company.

Remarks were also made during the evening by Messrs. W. J. Dealy, George H. Usher, "Senator" Ives and K. E. Brannin, while numerous recitations were given by Messrs. J. W. Kelly, E. E. Delaney and H. L. Nicholls, and song and piano recitals by Messrs. B. J. Knittle, F. Krummling, A. F. Hurd, D. W. McAneeny and C. Van Baar.

PROVIDENCE MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

To commemorate in a proper manner the completion of the first decade of the commercial use of electricity for the services of light and power, the National Electric Light Association invites all persons interested in electrical work or undertakings to join with it on the occasion of its Thirteenth Convention to be held in Providence, R. I., February 17, 18 and 19, in celebrating the close of the first decade of electric lighting, and in honoring the pioneers of electrical industries.

The following persons, representatives of the principal departments of electrical developments, have been invited to participate in the celebration, as the guests of the Association: Telegraphy, Dr. Norvin Green; Ocean Telegraphy, Cyrus W. Field; Telephoning, Alexander Graham Bell; Arc Lighting, Chas. A. Brush; Incandescent Lighting, Thos. A. Edison; Electric Street Railroad, Hon. Henry M. Whitney; Electric Welding, Prof. Elihu Thomson; Technical Education in Electrical Engineering, Gen. Francis A. Walker; Steam Engineering for Dynamo Driving, Gardiner C. Sims; Organization of the National Electric Light Association, Geo. W. Worthington.

The Association also invites all pioneer workers in electrical undertaking to participate in this celebration by their presence and by contributing for publication over their signatures an account of some interesting episode in their early experiences with electrical work. The morning session of the convention, on Wednesday, the 18th, will be designated "Memorial Session." and will be devoted exclusively to the recitation of such remembrances. All contributions will be published in the Volume of Proceedings after the convention, and will thus form a memorial of the beginnings of the electrical industries.

Appointments, Etc.

MR. SIMEON F. ELLIS has been appointed superintendent of the electric railroad at Quincy, Mass.

MR. B. J. WEEKS has been appointed superintendent of the Boston and Quincy electric railroad, with headquarters at Boston.

CHIEF THOMPSON, of the fire department, of Richmond, Va., has been appointed to take charge of the wiring in the new city hall in that place.

MR. THOMAS C. PERKINS, has been appointed electrical expert to superintend the installation of electric light wires at Bloomfield, Conn.

MR. CHARLES H. SPEAR has been appointed superintendent of street lights of Lynn, Mass.

MR. JACOB H. JACOBY has been appointed superintendent of telegraph on the Lehigh Valley railroad, Mr. J. W. [illegible] having resigned.

MR. J. J. RYAN has been appointed city electrician of San Antonio, Texas.

MR. W. L. BONNELL has been reappointed superintendent of the Norwalk and South Norwalk Electric Light Company, of South Norwalk, Conn.

THE TELEPHONE IN NEW YORK CITY.

The Metropolitan Telephone Co. has begun a crusade against the "Whisperphone" attachment to the transmitter. An interesting exposé has also been made of the plausible and peculiar schemes of the Telephone Subscribers' Association, one or two officers of which have been trying to render subscribers discontented at a charge of $5 per head for doing so.

INDUCTANCE AND ITS PROPOSED UNIT, THE "HENRY."

As noted in our last issue, a discussion of Mr. A. E. Kennelly's paper on the above subject, and also of the committee's report on the proper value of the Henry, took place at the 53rd meeting of the American Institute of Electrical Engineers, on Jan. 20th.

PROF. FRANCIS B. CROCKER read the report of the committee[1] and referred to the desirability of writing the plural of henry as "henrys." He considered it hardly necessary to settle upon any particular method of defining the unit because each one would choose whichever seems best.

DR. CARY T. HUTCHINSON remarked that if by the practical unit is meant the unit corresponding to the ohm, and which is an even multiple of the C. G. S. unit, then it would have one value. If, however, by the "practical unit" one meant that value which will fit the ordinary equation of induction, of which Ohm's law is only a special case, the unit would have another value. In other words, the unit of current in the electro-magnetic system is defined absolutely; the legal ohm, or whatever unit of resistance is chosen, is arbitrarily defined, and its relation to the ohm is determined experimentally. He thought the definition in terms of the centimetre was unfortunate, for the reason that its dimension, being a length, was purely artificial, and was so only on account of the "suppressed dimension." The definition should be in terms of the phenomenon; that is, the counter-electromotive force, expressed in terms to suit the C. G. S. "practical" or "legal" unit, as may be decided.

The speaker also objected to the adoption of the unit on the ground that the Institute lacked jurisdiction.

MR. TOWNSEND WOLCOTT, referring to the passage in Mr. Kennelly's paper, "It may be well to notice that inductance is only conventionally and perhaps not essentially a length," and to the remarkable quoted statements of Prof. Rücker on this point, called attention to the fact that they showed the amount of misapprehension which exists among scientific men regarding so simple a subject as the theory of the dimensions of physical units. Inductance was not a length; there was no room for a doubt regarding that question. To be sure, the *unit* of inductance had the dimensions of the *unit* of length in the electro-magnetic system of units, but then in the electro-static system it had the dimensions $L\ T$.

If inductance really were a length, not only ought we to be able to measure it by some of the methods of measuring length, but it would be absurd to encumber our nomenclature with a new name for an old unit. We should by all means stick to quadrant, or centimetre as the case might be. After what had been said it seemed almost unnecessary to remark that no discovery in science can change the dimensions of magnetic permeability, or of any other unit in either of the present systems of units. We might discover a better system of units, but that is all.

It had been shown that electric current had always the same dimensions as magnetic potential. There are two other quantities related in the same manner, namely, quantity of magnetism and electro-kinetic momentum of a circuit, m and p, have the dimensions in the two systems $[L^{1\cdot 2}\ M^{1\cdot 2}]$ and $[L^{3\cdot 2}\ M^{1\cdot 2}\ T^{1}]$. We may, therefore, substitute m for p in any equation without altering either the dimensions or the numerical value of the other quantities. It is on this principle that Sumpner and Fleming's definition of inductance is founded. Maxwell defines inductance as the ratio between the electro-kinetic momentum of a circuit and the current, that is, $\frac{p}{C}$. Sumpner and Fleming say, the ratio between the total induction (the same as Maxwell's quantity of magnetism), and the current. This is simply substituting m for p in the ratio giving $\frac{m}{C}$ = inductance. On the same principle we may substitute for the current the magnetic potential at a point where the solid angle is numerically equal to the reciprocal of the permeability when the ratio becomes $\frac{m}{\Omega}$, the quantity of magnetism divided by the magnetic potential, the analogue of the quantity of electricity divided by the electric potential or electro-static capacity. Electro-static capacity has the dimensions of a length in the electro-static system and of the reciprocal of an acceleration in the electro-magnetic system, just the reverse of inductance. The speaker expressed himself in favor of the quadrant value for the henry.

MR. GEO. A. HAMILTON referred to the fact that probably more was done, and at an earlier date, in the way of measuring self-induction than would be inferred from Mr. Kennelly's remark concerning the history of the same. Certainly as early as 1883, and he believed earlier, it was common practice with those in the telegraph service, to measure the *extra current* of the different forms of duplex and quadruplex relays that were brought out. He believed also, similar measurements were made in the British post-office service. Tests of this kind by himself were made by comparing the "kick" of the instruments under similar conditions in a balanced bridge, and also by shunting them with condensers of known capacity, and observing the reduced "kick." Regarding the name for the unit, he was decidedly in favor of the "henry," with "s" for the plural. He inclined also to 10^9 for its magnitude for the reasons given in the paper. He believed it would be found convenient in practice, and the micro-henry could take care of the small values.

MR. THORBURN REID believed that the committee ought to define clearly what the henry is to be the unit of. It was ordinarily called the unit of self-induction, but the term "self-induction" includes more and less than the quantity which is to be expressed in henrys. It is a general term connecting all the phenomena due to the creation of lines of force in a coil through which a variable current is flowing. Thus we have the E. M. F. due to self-induction, the lag due to self-induction, the work due to self-induction, the coefficient of self-induction, etc., any one of which the henry might be the unit of, and of only one of them it is the unit, namely, the coefficient of self-induction. All things considered, it appeared best to call the henry "The Unit of Inductance," a term suggested, he believed, by Fleming and used by Mr. Kennelly in his paper. In the next place it would be well to define exactly what this term "inductance" means. Fleming, using the ordinary term L to denote inductance, has defined it in three ways by means of the following equations:

$$L_1 = \frac{e}{\frac{d\,i}{d\,t}} \ (1) \qquad L_2 = \frac{N}{i} \ (2) \quad L_3 = \frac{2\,T}{i^2} \ (3)$$

In equation (1) e is the E. M. F. of self-induction. $\frac{d\,i}{d\,t}$ is the time rate of change of the current. In (2) N is the total induction through the coil, and in (3) T is the energy of self-induction. The second of these equations is inconsistent with the other two and is manifestly wrong. Thus the first of the three equations gives L as the ratio of the E. M. F. of self-induction to the time rate of change of the current; in other words, the E. M. F. of self-induction equals L times the time rate of change of current. He suggested that the committee define inductance according to the first and third of the definitions given above.

There was another consideration in favor of adopting as the unit of inductance 10^9 absolute unit, which he had not heard mentioned, and that was the fact that, in equations involving inductance along with other electrical quantities, we may perform directly all the algebraical operations without having to enlarge the value of L. There was another consideration bearing on this subject; the effect it was hard to predict at the present time. That is, the variation in the value of the permeability of iron and steel. This variation will cause the values of the henrys obtained by means of the first and third of the three equations to be different. Taking L as the ratio of the electromotive force of self-induction to the time rate of change of the current, we would get for a 10-light Westinghouse transformer and assuming a permeability of 800, nine henrys; this calculation would give .14 ampere as the current passing through the converter on open circuit, which is very nearly the actual current in practice. Taking the third definition, half of the magnetic energy of self-induction divided by the current, we get in this particular transformer something less than one henry. Exactly what that means he had not been able to make out as yet.

PROF. F. B. CROCKER, Chairman of Committee, said that in regard to the unit of inductance being a question of length, he did not suppose that there was any question that these dimensions are arbitrary to a great extent, and differ with each system, but the committee had adopted the electro-magnetic system; and we never use the electro-static system, and are not likely to use it. Therefore it does give certain importance to the dimensions of the unit, being always expressed in terms of that system and are always likely to be. Furthermore the language of the report, which, he presumed, brought forth this criticism, simply states that 10 to the 9th power absolute units of induction, shall express a length equal to one earth's quadrant, which is certainly a fact, and it was given more to show why it was called a quadrant; in other words, to cover the subject as far as possible. But however arbitrary the diminsions of the units, they are not absolute, but will change with the system, and as we were not likely to change the system, therefore, the diminsions are not likely to change.

As to the question of definition, he thought that was a very important matter. In regard to the criticism as to how the value of the unit will be affected by the variations in the value of the ohm or volt, that would take care of itself. Ultimately, he presumed, the volt will be the correct volt, and the ohm will be the correct ohm, and in that case the unit of self-induction will be the correct unit.

In regard to the importance of the unit of inductance, and the whole matter of self-induction, he believed that it would be used nearly as much as resistance, and that the unit of inductance would, in the future, have perhaps very nearly as many uses as the ohm. For example, in all alternate current work; in the telephone, and in the armatures of even the continuous current machines, the self-induction was as important, or more important, than the resistance. Therefore, this unit was destined to very extensive use, perhaps equal to that of any other electrical unit, with the exception, possibly, of the volt and ampere.

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[1] See THE ELECTRICAL ENGINEER, January 28, 1891.

The question of exactly what the unit applies to—what the conception should be aside from its value—a definition of that he thought was also very important. The coefficient of self-induction of course is the ordinary idea; but that is defined in terms of a unit change of current in a unit time. Now, as a matter of fact, supposing we have ten units' change of current in a unit time, then we have ten times the self-induction; the coefficient will be no greater, though. If we have a certain electro-magnet and we discharge it, we take out ten amperes of current, and cause ten amperes of current to cease flowing in one second. The actual self induction would be that due to the change of current, ten amperes in one second. The coefficient of self-induction would be calculated from a change of current of one unit in one second. Therefore, one might say that we have the coefficient of self-induction and the actual self-induction in any given case. It is perfectly possible that one might have a variation of a tenth of an ampere in a second, but the coefficient of self-induction would be that due to the unit change of current in a unit time. He thought that the distinction between the coefficient, which is a special case due to a unit change, or a unit variation of current in a unit time, was one thing, and the actual self-induction in any given case, which may be ten units of change or a tenth of a unit, was another thing. That was usually more important than the coefficient of self-induction, because that was what we actually got. The actual self-induction was very much more important than the coefficient of self-induction.

Mr. A. E. **Kennelly** remarked that as regards the apparent discrepancy between the dimensional values not only of inductance, but of every other quantity in electricity and magnetism as stated in the electro-static system or in the electro-magnetic system, the fact that there is a discrepancy shows the imperfection of our knowledge of the subject, because if we did possess more accurate knowledge, there could be one and only one true expression of length, mass and time, which would denote the quantity we study. Now it is a very important matter to know whether inductance can be truly expressed as a length or not. The common opinion is that it must be so, and it usually is so expressed. It can not in all probability be a length, because, as has been pointed out by several speakers, it is capable of being expressed in the electro-static system as the inverse of an acceleration. The whole subject, therefore, required some future revision, but when our knowledge becomes more perfect as we all expect it will be concerning the nature of these phenomena, so, proportionately, will our definitions be more clear, and there will be one, and only one definite expression of inductance considered in terms of length, mass and time.

As regards the right or the grace of the Institute in dealing with the question of what the name of the unit should be, perhaps, as had been pointed out, the lead in the matter should be taken by more strictly scientific bodies representing the country. But in this case, as in many others, it is the practical men who point out the requirements, and as a body of practical engineers, the Institute had a perfect right to set forth its necessities, to create provisionally, perhaps it may be, a practical unit for them, and to recommend the name of that unit to the next International Electrical Congress.

A very important matter was the question of how the unit shall be defined. If we had no iron it would be very simple, because all these three definitions of induction would all be one and the same thing in terms. But unfortunately in dealing with iron, we come across a difficulty. He differed with Prof. Crocker that to back electromotive force was the one which conveyed most clearly and most effectually the nature of inductance. When he saw a coil he could imagine the number of linkages with that coil, and more readily estimate in this way its inductance than he could by forming a conception of its counter electromotive force with change of current. That was, however, only a matter of opinion; but there was this advantage, that the method of referring inductance to the number of lines linked with a coil is one which is very fundamental and simple. It does not require any recourse to the differential calculus, as the others do, because the time rate of change has to be defined as the instantaneous time rate and not the time rate in any actual period elapsed.

The only hope, as it appeared to him, is to specify that inductance shall be expressed by any of those three definitions, and then to say that the inductance with iron has to be referred to the inductance that would exist without the iron by the use either of the specified conditions of the test, or of the specified conditions of the iron.

Mr. C. O. Mailloux thought that the remarks of Prof. Crocker in reference to expressing inductance in terms of counter E. M. F., constituted a suggestion of some importance. In practice with alternating currents, we do not deal with the instantaneous values of current or E. M. F. but we make our calculations on the basis of mean effective or average values corresponding to a given cycle or period of the electrical action. Inductance has been defined as the product of a length by a permeability, with the assumption that the permeability is unity. Now we might express the inductance as the product of two factors, one of which is a coefficient simply whether we regard it as representing *length* or anything else (we might, if we prefer, call it a *length* factor or coefficient); the other factor being what might be termed the "mean effective permeability." Since the permeability undergoes a series of variations when the current rises from zero to the upper limit or maximum value reached in the given cycle, we have a series of values to consider. If we multiply this mean value by the length factor we have the mean effective value of the inductance. What we usually get, when we measure inductance is in reality the product of those two factors. Unfortunately we do not have the means of separating them, unless we regard the length coefficient as the inductance value that would be obtained if the iron were removed from the magnetic circuit; and regard the other factor (the mean effective permeability) as the factor indicating how many times the inductance is increased when the iron is present. The principal thing needed was a value for the inductance which can be treated as if it were constant for a whole cycle, or a whole period, and which will reconcile theoretical ideas with practical requirements. He saw no difficulty in this way of approachihg the question.

Prof. Crocker replying to Dr. Hutchinson said he thought it would be a great mistake to define the henry in terms of legal volts and ohms or whatever may be involved in the definition at the present time, making it necessary to change that dimension at some future date.

Mr. Charles Steinmetz remarked that when one took into consideration the fact that this term inductance will be used mainly for explaining and calculating the phenomena of alternating currents, then the suggestions that Mr. Mailloux made—the introduction of this "effective value" of inductance—he supposed would be found more useful than even the true analytical term, inductance. He did not consider the choice of the name "effective" as a happy one, because that suggests something of the nature of a square-root of a mean square, and this value, which Mr. Mallioux meant was not the square-root of the mean square of the different values of inductance during the magnetic cycle, but was, in reality, very nearly the inductance for that value, which corresponds to the maximum magnetization used, and therefore he would prefer another name, which is not so liable to be misunderstood, for instance, "resulting inductance." He had had occasion to make over a thousand determinations of the value of self-induction, and of the work consumed by hysteresis, over a very large range, up to values where the hysteretic loss amounted to more than a thousand watts, and he always found the value of inductance very near the value previously calculated for the maximum magnetization of the cycle.

Mr. Kennelly thought it safe to say that the concensus of opinion at the present time among the members, was in favor of adopting 10^9 centimetres as the practical unit, the henry to be spelled in the plural "henrys," and that there was no difficulty in defining it in a copper coil which has no iron in it or near it, because it may be defined with equal truth in any one of three ways, those three ways giving the same result at all times, and for all currents. That so soon as iron is introduced, the inductance would probably vary with the way in which the measurement is made, the time during which the current is changing, and the value of the current, and the only way out of the difficulty from a general standpoint, was to define inductance as though there were no such thing as iron, and then to say that when we are measuring any inductance which is iron-clad, to specify the current used, and the way that it is obtained, so as to arrive at the permeability of the iron at that moment and its rate of change.

Letters to the Editor.

THE CONDITION OF THE PATENT OFFICE.

Cannot something be done to arouse the attention of Congress to the inadequate provision for the transaction of business at the Patent Office, and the care and safety of the valuable archives? I was there a few days ago, for the first time in many years, and was surprised and annoyed to see that notwithstanding the great growth of the business, but little more space is available for the use of officials and employees than they had at command thirty or forty years ago. The important work of the examiners is performed under the most unfavorable conditions. Although the rooms allotted to them are but of moderate size, it seemed to be the rule to crowd from ten to fifteen people in one room. Of course it is impossible but that there should be a large accummulation of papers, considerable confusion, and consequent loss of time. The rooms occupied by women were even worse crowded. To say nothing about health conditions, it is impossible that the public business can be properly conducted under such circumstances. Then, consider the disastrous consequences of a fire which should make headway in the building. Patented inventions enter into our great industries as never before in any other land. How important it is that the record of protected inventions should be preserved unimpaired!

While I was in Washington, the entire time of Congress was taken up with the consideration of such subjects as the Force Bill, Cloture, &c., matters which were destined to come to naught. And I could not help thinking, as I saw the neglected condition of the Patent Office, how much to be desired it is that Congress should call a halt as to its abortive discussions of partisan schemes, and bestow a little attention upon the material interests which are suffering sorely for the want of that consideration which of right should be extended to them. And I contrasted the reprehensible squandering of the public money on fraudulent pensions and on venal pension agents with the niggardly treatment of the Patent Office, and other departments equally demanding the attention of the public servants. It is too bad that there should be such a misappropriation of time and money. And I fervently hope that in some way the attention of Congress to this meritorious subject may be compelled. H. H.

PROVIDENCE, R. I., Jan. 30, 1891.

Reports of Companies.

STANDARD UNDERGROUND CABLE CO.

The annual meeting of the Standard Underground Cable Company was held January 27, at the company's office in the Westinghouse Building. It was well attended by the stockholders, there being nearly 9,000 shares of stock represented. Mr. George Westinghouse, Jr., was elected president; and the following were elected directors: George Westinghouse, Jr., Mark W. Watson, John H. Dalzell, Robert Pitcairn, Joseph W. Marsh, James H. Willock, and H. S. Sweitzer.

The annual report of the board of directors was exceedingly gratifying to the stockholders. It showed that the company's business for the year 1890 amounted to $917,646.62, representing an increase of 50 per cent. over the business done in the year 1889. The net earnings for the year 1890 were $204,913.78, or a little over 20 per cent. on the entire capital stock; two dividends aggregating $30,000.00 were paid during the year, leaving the net addition to surplus account $174,913.78. The company's net surplus on December 31st, 1890, was $315,735.85.

The raw materials used by the company during the year were as follows: 342.549 pounds of cotton and jute yarn, 1,625,209 pounds of copper, 1,853,538 pounds of lead.

During the year 1890, the company added 84 new customers to its already large list, and its business covers a wide range of territory, as is graphically illustrated by the large map of the United States shown in the company's office, nearly every state and territory of which is dotted with circles or crosses indicating the cities in which the company's underground cable and overhead wire, respectively, are in use; and the markings on Johnson's Commercial Chart of the World show that the company's business is not limited to the United States, but extends to Mexico, South America, Europe, Africa, Asia, China and Japan.

STOCKS AND BONDS.

HOLLEY, N. Y.—The Holley Electric Co. shows capital stock of $7,500.00, all of which is paid in. The debts of the company are $65.23 and a surplus of $475.90 over all liabilities is reported.

KALAMAZOO, MICH. The City Electric Company, of Kalamazoo, Mich., has increased its capital to $60,000.

HARLAN, IOWA, has voted to extend the city limits and bond for water works and electric light.

LYNN, MASS.—The stockholders of the Lynn & Boston Railroad Company have voted to petition the Railroad Commissioners for authority to increase the capital stock by an amount not exceeding $500,000 for expenses to be incurred in adopting electricity as a motive power.

RUTLAND, VT.—In accordance with a vote of the stockholders of the Rutland Electric Light Company, the capital stock of the company has been increased from $50,000 to $100,000. It is divided into 5,000 shares of $20 each.

DIVIDENDS.

FALL RIVER, R. I.—The Edison Electric Illuminating Company, of Fall River, has declared a quarterly dividend of 2 per cent.

ELECTIONS.

NEW YORK CITY.—At the annual meeting of the American Range-Finder Company the following officers were elected: President, Edward A. Wickes; secretary and treasurer, D. W. McWilliams; directors, Edward A. Wickes, A. J. Forbes-Leith, D. W. McWilliams, S. D Schuyler, and Richard Irvin, Jr. It was stated in the course of the meeting that the Russian government had already purchased one of the Fiske range-finders and that they are now undergoing trials by other foreign governments with a view to their introduction into the navies of those countries.

Home Correspondence.

BOSTON.

"Electrical Bohemia."—M. E. E. & M. A.

THE members of the Boston Electric Club listened to a very entertaining and instructive paper at the Club rooms this week, by Mr. F. M. Gilley, associate editor of *Electrical Enterprise*, a new electrical journal which is springing into prominence amongst the electrical papers published in Boston. The subject of the paper was "Electrical Bohemia," a name, however, which did not at all prepare one for the interesting lecture which followed. Mr. Gilley described in some detail, and in a somewhat humorous manner, a recent trip made by himself to England and France, and gave many interesting details of electrical progress, or rather want of progress, in these countries. The various central electric light stations in London and Paris, the underground electric railway in London, and the system of underground conduits in Paris were all briefly described, and special mention was made of the extensive house lighting by electricity in London. The subject was described in an able, racy and comprehensive manner, and spoke volumes for Mr. Gilley's powers of observation of the methods of our friends on the other side. At the close, a few remarks were made relative to the topic under discussion, and a unanimous vote of thanks was passed to Mr. Gilley for his successful effort to interest, please and entertain the members of the club. *Electrical Enterprise*, the journal above referred to, was started at the beginning of this year, and has now reached its fourth number. The staff of the paper consists of Mr. John G. Lynch, editor; Mr. Frank M. Gilley, associate editor, and Mr. Albert P. Bicknell, manager and publisher. Now that the young paper has got a footing on the threshold, I desire to extend it a welcome as a contemporary, and trust that the same good work which has appeared in the first four numbers may be continued, and wish them a hearty success. The tone of the paper, though not technical, is newsy and the editorials are bright and clever, and deal in an enterprising way with the electrical topics of the day.

The Massachusetts Electrical Engineers and Mechanics' Association gave their first annual ball in Odd Fellows' Hall, on Thursday evening, the 29th inst. Naturally, the members, being largely composed of electrical men, turned their attention to the special decoration of the ball room, and succeeded in producing a dazzling effect. Mr. N. Olsen, chief decorator, had charge of the arrangement, and used just exactly 497 incandescent lamps. The words "Welcome, M. E. E & M. A." were formed of a number of lights over the platform, while suspended from the centre of the hall was a representation of Ben Franklin's famous kite, also composed of electric lights. From the centre to numerous points on the way, stretched long streamers of bunting with lamps at intervals, of various hues, and all round the room lamps were distributed in lavish display. A switchboard had been provided with 22 circuits by which all sorts of marvellous effects could be had by the blending of the different colors on the various circuits. All the lamps, apparatus, current and wire were loaned by the Edison Illuminating Company, while the work itself was done by members in spare moments. The reception committee was headed by Mr. John Dean, Jr., the committee on order by Mr. S. F. Lawton, and the corps of floor directors by Mr. Frank O. Johnson. To the efforts of the affable president of the Association, Mr. James E. Cole, the generally agreeable results of the affair were greatly due. A most enjoyable evening was spent, and a very comfortable sum of money was realized, which will be spent in procuring a suitable library for the Association.

BOSTON, Jan. 31, 1891.

Obituary.

MR. N. E. SWARTWOUT.

Nelson E. Swartwout, who committed suicide at New Orleans recently, was formerly a resident of Chicago, and was at one time a well-known electrician. For eight years prior to 1884 he was private secretary to Professor Elisha Gray, of Highland Park, through whom he became widely known. In 1884 he was made secretary of the old Sectional Underground Conduit Company, which office he held until Professor Gray gave up the management of the affairs of the company in 1887. Since that time Mr. Swartwout had served in several positions, among them the managership of a large hotel at St. Paul. He leaves a wife and daughter in this city.

TELEPHONE vs. ELECTRIC RAILWAY.

Two suits for damages have been filed by the Cumberland Telephone Company against the United Electric Railway Company, of Nashville, Tenn., one for $5,000 and the other for $7,000. The actions are based on alleged damage to the complainant's wires by the defendant.

FIRST ANNUAL REPORT OF THE ELECTRIC MUTUAL INSURANCE COMPANY, OF BOSTON, MASS.[1]

The causes which induced the formation of this company were the following:

The exorbitant rates and exacting conditions imposed by "stock companies"—the difficulty, even of procuring necessary reliable insurance in those companies on electrical risks, together with the vacillating action in the matter of rates, which are subject to the whims and prejudices of local boards and compacts; and also the realization that the enormous capital invested in electrical industries requiring insurance called for a company of its own. The unfairness of the stock companies' rates (notwithstanding their protestations to the contrary) can have no more potent demonstration than the present alacrity with which they are now *reducing* them *almost one-half* wherever and whenever they feel the competition of our company. Such reductions are not made, however, until our competition is felt.

About the first of January, 1890, a prospectus was sent out setting forth the purposes and prospects of the Electric Mutual Insurance Company and calling for pledges of insurance to secure incorporation and authority to begin business under Massachusetts law. Not less than $500,000 insurance, covering at least 200 separate risks was required. More than double the required amount was pledged, and an organization and incorporation was at once effected. The company issued its first policies on the 15th of May. This report covers the operations to the close of business December 31, 1890—7½ months.

By the treasurer's report you have seen that the outstanding risks amount to the large sum of $2,897,587, the premium on which is $30,320.71—an average rate of about 1⅛ per cent. The average amount of policies is $9,055. The actual cash assets, after paying every dollar of taxes, expenses (including costs of organization, equipment of office, etc.) and losses, amount to $18,907.04, a result, we believe, that is unprecedented in the formation of mutual fire insurance companies.

Not a risk has been assumed that has not either been personally examined by a representative of the company, or the fullest detail and description submitted by the member insuring, in writing, upon blanks of the company provided for the purpose. Not a risk is outstanding that, has not been improved electrically (where improvement was needed), nor that is seriously exposed or without good facilities for extinguishing fire. Nothing can better attest those facts than the statement that not a dollar of loss has occurred on any station insured.

If the experience of the company during the first eight months continues to the end of the first year, we shall be able to pay back to members 50 per cent. of the premium paid for their policies, and add to our reserve besides. Your directors have confidence to feel that so soon as our volume of premiums shall have grown large enough to reduce the ratio of expense to that of the "Factory Mutuals" (about 10 per cent. of premiums) dividends on profits can be made on expiring policies equal to that paid by those companies, which averages nearly 75 per cent. But if *no dividends* were anticipated from the company, your directors feel that a large part of its mission has been accomplished in the material lessening of rates which it has already caused, the average prevailing rate of "board companies" previous to its advent having been about *two* per cent., while, as shown by your treasurer's report, our average is but a trifle over *one* per cent., and we have compelled the board companies to make similar reductions. We predict that they will bid still lower.

The fact should be borne in mind that their seeming magnanimity in reducing their rates will only last while the competition does. To the importance of sustaining the company as a competitor and controller of rates, should be added and considered the fact that insurance upon the mutual plan adopted by us will be furnished at *cost*, shorn of all the expensive machinery and toll-gathering in the way of agents' commissions, such as pertains to the agency system of stock insurance. Of every dollar in premium charged for stock policies, *twenty-five per cent.* does not reach the companies. A still further deduction must be made for expenses, and a profit must be secured for *capital* invested, which is surely not needed to pay for *isolated* electric plants that do not burn each other. Capital *is* needed, however, when the great mercantile or business centres of cities burn up and destroy hundreds of risks for each company—hence the absolute necessity for large capital with companies doing a miscellaneous business. It should be still further considered that the agent who secures electric risks and receives for his compensation a *commission* on the premium collected, has an incentive to take risks with *less caution as to desirability* than he would if his sole aim were the welfare of his company and the interests of the insurers therein.

Stock companies are not prone to furnish insurance any great length of time at *less* than cost, and in view of the facts presented your board feels that you will not long hesitate as to which system offers the more favorable prospects.

We are pleased to say that a most satisfactory arrangement for exchange of business with several of the factory mutuals was concluded shortly after we began operations, and by which arrangement surplus insurance secured by this company, amounting to over one and one-half million dollars, has been placed with those companies at the same rates charged by this company. In return about eight hundred thousand dollars insurance on isolated manufacturing properties fully provided with automatic sprinkler equipments, pumps, hose, etc., insured by them, has been placed with this company.

We could ask no stronger endorsement of our methods and management, not of the desirability of electrical risks, than that which is manifested by the ready alliance of those companies with us. Their record will seem marvelous to those not familiar with it. The first of those companies began over forty years ago and there are now about twenty-five of them. They insure the large cotton, woolen, paper, metal and other manufacturing corporations in the Eastern and Middle States, and to considerable extent in the South and West. Their insurance aggregates over *five hundred million dollars* annually, the cash premium averaging about one per cent. After the payment of losses and expenses the profits have enabled them to pay back to each policy-holder an average of about *seventy-five* per cent. of the cash premium paid for the policy, so that the actual cost of insurance has been only *one-quarter of one per cent. or less*, annually.

They have in the meantime reserved of their earnings from year to year, funds ranging from $50,000 to $900,000 each, thus making the contingency of an assessment so remote as to hardly be a factor in their calculations. In order, however, that they may be in position to pay their losses even under *unprecedented and unexpected disaster*, and to meet the claim of competitors "that they have no *capital*," they have a "contingent, or assessment liability," which is limited to five times the cash premium. Their loss-paying resources are, therefore, about six times their annual premium receipts, as they have always at least one year's premium in hand. It is perhaps needless to say that in their whole existence (dating back forty years) they have never called upon the assessment obligations.

Precisely the same plan was adopted in the formation of the Electric Mutual.

The closing months of 1890, witnessed the retirement (either voluntarily or upon compulsion of State authority) of about twenty so-called "Mutual" fire insurance companies in the Western States. A majority of them have been *masqueraders* under the popular name of mutual, for, in fact, their business has not been confined to any particular class of risks nor conducted upon any of those principles that have achieved such successful and satisfactory results in the New England States; but on the contrary, their risks have mostly been secured through "brokers," on the large mercantile and miscellaneous properties of the cities, and almost wholly at rates ridiculously inadequate for *such hazardous risks*. The inevitable result of securing business through such channels is to get those risks that have been rejected by well managed companies, and in addition to that fact and the extreme unprofitableness of such business at the low rates obtained, the "brokers" have taken their toll of 25 per cent. or more from the premium. Investigation has found "crookedness" at the bottom of some of those companies. Our reference to the subject in this report is to call the attention of our members to the distinction between legitimately conducted mutual insurance and the premium-gathering masqueraders conducted or supported by "brokers" whose only interest in the concern is the "commission" they can reap by having the premium pass through their hands.

Many of the electric stations throughout the West we find have been compelled to insure with those concerns by reason of the excessively high rates imposed by stock companies and their reluctance to take the risks even at their own rates. We incline to the belief that the life of many of the Western mutuals has been prolonged by the profit yielded from premiums on electrical risks, which they freely took, *not* through any wisdom of choice, but simply because of the premium offered.

Several fires have occurred in electric stations, but nearly all have been traceable to carelessness of construction, or failure to provide any facilities for the extinguishing of fire, faults due wholly to the unusually rapid development of the industry. A more deliberate, permanent, and extensive era of construction has set in and the mistakes and neglects of the past are not being repeated.

Your board feels that you and those engaged in electrical development generally, will not fail to appreciate the good results that will follow, and the fire losses that may be avoided by, the dissemination of practical and valuable ideas pertaining to safety, through the intelligent inspection of its risks by an insurance association devoting itself especially to the electrical business. The excellent results obtained by the factory mutuals have been due to the avoidance of "normal hazard" by their careful selection of risks, and intelligent inspection of the same, coupled with the interest that each insurer has in the welfare of the companies.

There is surely no other industry whose best interests can be served to so great a degree by the absence of fire loss as can the electrical; and therefore we feel confident of the wisdom shown in following the lead of those mutual companies whose plans we have adopted and with which we are so agreeably working.

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[1] Presented to the Board of Directors, January 20, 1891, by S. E. Barton, president.

The business written by the Electric Mutual thus far in January swells its premium income to thirty-four thousand dollars, with every indication that the month will show an increase over the preceding month, which has been the case with each month since we organized. Adding the normal increase of new business to the renewals after one year shall have been passed, there is good reason to anticipate not less than one hundred thousand dollars premium income during our second year.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JAN. 27, 1891.

Accumulators:—

Secondary Battery, C. F. Brush, 445,422. Filed June 9, 1881.

Claim 1 follows:

The method of making a secondary battery element, consisting in producing on a suitable body, frame or support a coating or filling of electrically-deposited spongy lead, then immersing the frame or support thus coated in a battery fluid in which said coating is insoluble, and peroxidizing the coating by electrical action.

Alarms and Signals:—

Electric Bell, J. F. Wollensak, 445,295. Filed Sept. 29, 1890.

The bell has independently adjustable magnet-spools movable toward or from the armature.

Circuit Controller and Alarm, C. M. Woolcott and Albert E. Wilmot, 445,306. Filed Oct. 16, 1890.

Especially applicable to the detection of leaks in automatic sprinklers for extinguishing fires, but applicable to other similar purposes. Claim 1 follows:

A circuit-controller of a conducting material which is dissolved or softened by water, in combination with circuit terminals electrically connected thereby.

Electric Guest-Call, A. Striemer, 445,341. Filed July 29, 1890.

Contains a rotating cylinder provided with a spiral rib, a series of call-bells and a battery in partial circuit with the cylinder. and a series of springs arranged to be successively engaged by the rib on the cylinder, and wires connected with the bells and arranged to be connected with any of the springs.

Leak Detector for Pipes. A. H. Brown, 445,495. Filed Sept. 20, 1890.

Relates to detectors as shown in same inventor's patent No 401,409, April 16, 1889. Applicable especially to fire extinguishing sprinklers.

Conductors, Conduits and Insulators:—

Electric Cable, J. C. Reilly, 445,234. Filed May 20, 1890.

An anti-induction cable. The several conductors are systematically, and at regular intervals, displaced as regards the contiguous parallelism of any given pair, reducing the contiguous parallelism of any two conductors to a minimum.

Electric Cable Connector, S. Bergmann, 445,365. Filed July 24, 1890.

For splicing sections of cables or conductors abutting end to end. Consists of a tapered metal strip which is wound about and soldered to the conductors, the wide end of the strip being first applied to the joint.

Dynamos and Motors:—

Electro-Magnetic Motor, N. Tesla, 445,297. Filed May 20, 1889.

Improvement in alternating current motors of the type previously patented by Mr. Tesla, in which two opposite poles of the field magnet, say in a four-pole machine, have primary coils, connected in the main circuit and also secondary coils which are closed through the coils on the other two field poles, and having an armature of closed coils; the difference in phase between the alternations of current in the primary and secondary windings serving to shift the polarity and cause rotation of the armature. The claims of the present patent include the difference in electrical character, resistance or length of the primary and the secondary field windings.

Commutator-Pattern, P. F. Lenhart. 445,319. Filed June 17, 1890.

A pattern for casting all the metallic sections of a commutator, or dymamos or motors, at one operation.

Regulator for Dynamo-Electric Machines, J. H. Holmes, 445,448. Filed May 14, 1890.

Relates to maintaining a constant difference of potential at the terminals of a dynamo supplying currents for lighting railway trains.

Claim 1 follows:

In electric machinery for lighting railway trains, a generating-dynamo the field-magnets of which have, in addition to the ordinary shunt-wound exciting circuit, a supplementary circuit. connected to an independent source of current, and having in series with it the armature-circuit of a regulating-dynamo driven at the same speed or subject to the same degree of speed-variation as the generating-dynamo, the electro-motive force of the regulating-armature being made to oppose the electro-motive force of the independent source of current, so that its variation in proportion to the variations of speed will practically maintain constant the electro-motive force of the dynamo.

Electric-Motor, W. M. Dresskell, 445,499. Filed June 9, 1890.

The invention consists of a construction and connections adapted to enable the windings of the armature to be connected up in series or in parallel at will.

Commutator Brush-Holder for Electric Motors, G. H. Condict, 445,521. Filed Apr. 18, 1890.

Particularly applicable to motors employed for traction purposes, where there is difficulty in properly keeping the brushes in adjustment on account of jarring. The holders, movable to or from the commutator, are provided with a screw-threaded tension-rod for drawing them toward each other, and an adjusting nut supplied with a weight whereby the nut may be maintained in any predetermined position and prevented from turning by the jarring of the machine.

Galvanic and Thermo-Electric Batteries:—

Galvanic Battery, W. A. Crowdus, 445,425. Filed Oct. 7, 1890.

Relates to two-fluid batteries in which a porous diaphragm or partition is employed, and has for its object to reduce to a minimum the internal resistance without increasing the osmosis of the fluids. The inventor employs, in conjunction with a non-conducting porous partition, a conducting porous partition, arranged against, and co-operating with a non-conducting partition, thus reducing the thickness of the latter.

Lamps and Appurtenances:—

Electric-Arc Lamp, J. A. Hayes, 445,176. Filed April 23, 1890.

An arc lamp in which both the upper and the lower carbon are fed. The feed is effected through the movements of a pinion, rack and a ratchet wheel.

Electric Cut-Out, J. S. Potter, 445,253. Filed Aug. 16, 1890.

Especially applicable to incandescent lamp circuits, and includes a safety fuse.

Electric Switch, G. Cutter and C. G. Armstrong, 445,310. Filed July 31, 1890.

A quick-acting or "snap" switch, for electric lighting circuits, particularly adapted for circuits of from four to six incandescent lamps.

Cut-Out, S. Bergmann, 445,362. Filed Jan. 25, 1890.

For incandescent electric lamps.

Electric Cut-Out, S. Bergmann, 445,363. Filed Feb. 17, 1890.

For incandescent lamps. Consists in a pendent or other fixture tube or arm having a seat adapted to receive a cut-out, and a cut-out removably secured in said seat.

Key for Electric Cut-Out, S. Bergmann, 445,364. Filed May 5, 1890.

For incandescent electric lamps. Intended to provide a cut-out to the shaft of which any key or finger piece may be attached.

Manufacture of Carbon Filaments, W. M. B. Keen and W. F. Haarmann, 445,374. Filed June 19, 1890.

Intended to produce a filament strong, elastic, flexible, durable and very dense in structure. The inventor describes the principle of the invention as similar to that employed in the manufacture of beer. The process consists in saturating a ligature of vegetable or animal fibre, such as cellulose or silk, with a mixture of hops and a solution of saccharine matter and glue, concentrating the mixture by boiling, drying the saturated material, and then carbonizing.

Miscellaneous:—

Thermal Cut-Out, A. Barrett, 445,217. Filed Dec. 5, 1890.

Especially applicable for the protection of telephone and telegraph apparatus from injury by too powerful currents. An attenuated and fragile conductor, included in the circuit to be protected, is attached to a strong spring, or equivalent device, capable of rupturing it, but is protected from the action of such spring under normal conditions by being embedded in a mass of material which is ordinarily solid but which will soften or disintegrate under the influence of heat.

Coin-Controlled Electric Coil, E. J. Colby, 445,220. Filed Oct. 17, 1889.

A "nickel in the slot" shocking machine.

Railways and Appliances:—

Motor-Truck for Cars, J. A. Brill, 445,308. Filed Oct. 3, 1890.

Claim 7 follows:

In a pivotal car-truck, the combination of a car-body mounted upon a truck, said truck having a frame, forward and rear axle boxes, axles and wheels, a pivotal centre directly over the centre of one of the axles, a motor sleeved to the axle over which the pivoted centre is located, and springs for supporting the free end of the motor mounted upon the truck frame.

Turn-Out for Electric Railways, R. M. Hunter. 445,409. Filed June 29, 1887.

Embraces turn-out devices for the conductors on a single track railway and a pair of trolley wheels riding on top of the conductor.

Electric Connection for Track-wiring, S. H. Short, 445,479. Filed Oct. 10, 1890.

Claim 3 follows:

The conducting system or track-wiring, comprising a main-track wire or wires, branch wires, and grooved or open-sided connectors having the said wire fixed in the grooves or sockets of said connectors, which thus couple the branch-wires with the main-track wires.

Conductor-Switch for Electric Railways, F. J. Sprague & J. F. S. Branth 445,515. Filed Sept. 27, 1888.

Relates to frogs or switch-plates for crossing or branching lines. The switch plate has a movable deflecting-rib for guiding the contact wheels across its surface; the switch-plate is provided at its extremities with depressing-ribs to avoid impeding the movement of the trolley when entering the switch-plate.

Telegraphs:—

Telegraph Key, J. Doggett, 445,442. Filed July 28, 1890.

A combination key and sounder.

Telephones and Apparatus:—

Telephone, E. Noriega, 445,475. Filed Oct. 2, 1890.

The transmitter has a diaphragm of wood or similar material with annular electrodes sliding upon a cylindrical electrode.

Legal Notes.

SUBWAY INJUNCTION IN NEW YORK.

Mr. Edward Henry's application for an injunction to restrain the Board of Electrical Control from making any contract with the Empire City Subway Company, Limited, for the construction of subways, and from taking any action toward relieving the Consolidated Telegraph and Electrical Subway Company from any of its obligations under its contract until the same should have become ineffectual, has been granted by Judge Truax, of the Superior Court.

Although the action was brought by a taxpayer, the high-tension electric lighting companies were the real parties interested in having the board restrained from making the new contract under which the high and low tension systems, it was alleged, were to be separated.

SAN ANTONIO, TEX.—The Alamo Electric Street Railway Co. has been granted an extension of time of four months in which to complete the railway for which a franchise was granted last May. The company claims that the delay was occasioned by no fault of its own, but through its inability to get the rails, etc., at the time specified in the contract, and many other unavoidable causes.

THE
Electrical Engineer.

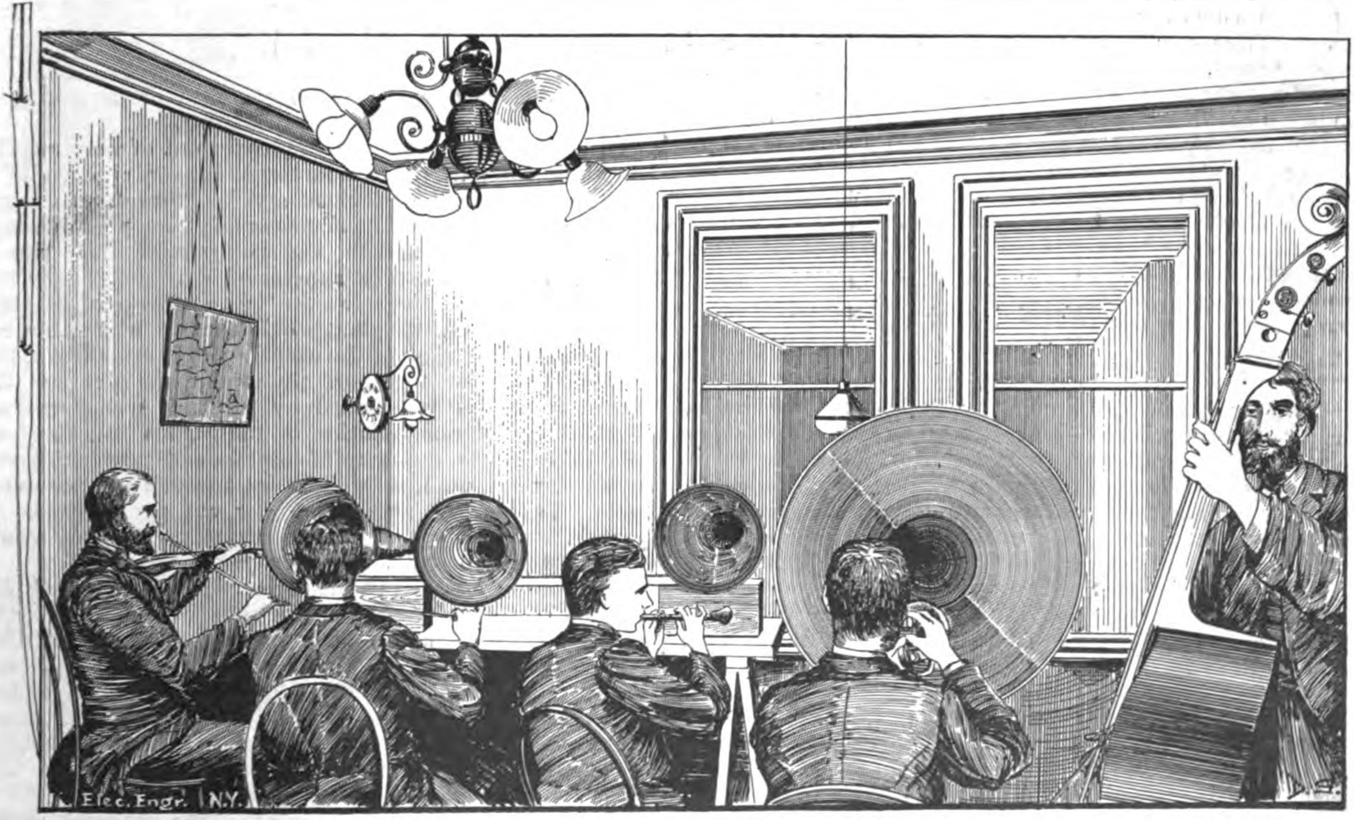
Vol. XI. FEBRUARY 11, 1891. No. 145.

LONG DISTANCE TELEPHONE CONCERTS.

ONE of the most interesting developments of telephone work is that which is now steadily going on—the transmission of orchestral music over long distances. Our readers will recall the large measure of success attained during the exhibition of the Women's Exchange at the Lenox Lyceum last winter, when, besides the transmission of music from the local theatres, Boston contributed to the entertainment by telephone, in the shape of music and recitations.

This work has been carried on by the American Telephone and Telegraph Co., known as the "Long Distance Company," under the direct supervision of their able engineer and electrician, Mr. F. E. Pickernell, and the results obtained with but a comparatively short experience in so difficult a field are exceedingly gratifying and give promise of still greater success in the near future.

In a lecture recently delivered in the Town Hall at Newton, Mass., Mr. Pickernell described the methods employed in the transmission of music by telephone. His remarks were very forcibly illustrated by the reception in the lecture hall of music transmitted over the Long Distance lines from the Telephone Building, at No. 18 Cortlandt street, New York, and our engraving, made from a photograph taken at the time, shows the arrangement of the performers.


Elec. Engr. N.Y.

A Long Distance Telephone Concert.—Performers in New York, Audience at Newton, Mass.

In transmitting music of this kind, it has been found desirable to have a separate transmitter for every instrument, and further, that, where a considerable number of instruments are used, it is necessary to so arrange the induction coils that their joint resistance will bear a fixed ratio to the resistance of the receiving instruments and line, all the induction coils being connected by the same line in multiple series.

For this class of work the storage battery is admirably adapted for operating the transmitters, and by using cells of this type, it is possible to run 20 long-distance transmitters from the same battery without drawing a current sufficiently heavy to injure the storage battery.

By using separate transmitters for each instrument, due prominence may be given to each of the instruments at the receiving end. If one transmitter is arranged to transmit music emanating from 50 instruments, it has been found that it must be so adjusted that the average result will be fair. Under these conditions, the lighter violin parts are heard but very indistinctly, while the heavier parts produce very great noise, but the purity of the sound is affected. This of course gives very unsatisfactory results.

At the receiving station, when it is desired to fill halls of considerable size, as many as six loud-speaking receivers are used. These are connected in multiple series, so that their joint resistance bears a definite ratio to the resistance of the transmitters; these are distributed about the hall, being usually attached to the chandeliers.

On the occasion above referred to, the music transmitted from New York over a distance of 250 miles was listened to by an audience of over 1,000 persons.

When we add that similar entertainments have been given with music transmitted over a distance of no less than 460 miles it will be clear that if the same progress is made in the future as that characterised by the work of the last few months, the telephone will occupy an important position in our future entertainment, both public and private.

NOTES ON ELECTRO-DEPOSITION.

BY

Gilbert Wilkes.

I HAVE read with much interest the articles on "The Arrangement of Vats in Electro-Deposition," by Mr. C. O. Mailloux, in the recent issues of THE ELECTRICAL ENGINEER, and think that the subject is of sufficient importance to justify some further attention, as well as a few remarks upon the above mentioned articles.

Let $R =$ resistance of the liquid in one vat.
$r =$ " " plates "
$\varepsilon =$ counter electromotive force of one vat.
$E =$ potential difference between the terminals of one vat.
$C =$ current.
$W =$ energy consumed.

Equation (2) of the articles mentioned above gives—

$$E = C\,(r + R) + \varepsilon.$$
$$= C\,(r + R + \rho).$$

The second part of this equation is evidently incorrect. $E = C\,(r + R) + \varepsilon$ expresses simply the condition in a circuit in which there is not only an ohmic resistance but a true counter electromotive force. Were $E = C\,(r + R + \rho)$ correct, there would be no part of the equation which would not vary with the current, and the values of $(R + r)$ and of ρ could not be separated. This is not the case, as in fact the way in which the value of ε is determined is by taking advantage of the fact that it does not vary with the current. This is accomplished by taking successive readings of E with different values of C. Thus, using primes to denote a second case

$$E \;= C\;\;(R + r) + \varepsilon \qquad (a)$$
$$E' = C'\;(R + r) + \varepsilon \qquad (b)$$

Solving, $$\varepsilon \;= \frac{C'\,E - C\,E'}{C' - C.} \qquad (c)$$

Considering that ε, the quantity to be obtained, under proper conditions, is less—and often much less—than 10 per cent. of the quantities observed and from which it is obtained by a difference method; that the conditions are necessarily unfavorable to accurate observation, and that the material attacked at the anode is constantly varying, the values of ε do not vary more than one would expect.

In the case of copper refining by electrolysis, ε must of necessity be small and will, in general, be opposed to the flow of current. The purer the plates, the smaller will ε be, which will assist in accounting for the various values given by different writers. Also, the presence of other metals, such as antimony, bismuth, arsenic, etc., must affect the value. We all know that two pieces of the same copper wire, plunged in acidulated water and put in circuit with a sensitive galvanometer, will give a decided deflection. Imagine then the effect of small quantities of all of the above metals, native and as compounds in an acidulated solution, upon a counter electromotive force of a few hundredths of a volt, and there will be no difficulty in understanding variations in ε—small in themselves, but proportionately large in comparison with ε.

A simple demonstration of the fact that a practically unlimited amount of copper *may* be refined with a given appreciable power can be derived as follows:—

Let the total number of vats $= n\,m$, arranged in n series of m vats connected in parallel. Then, keeping C constant

$$E_{n\,m} = n\;C\,\frac{R + r}{m} + n\,\varepsilon \qquad (d)$$

$$W_{n\,m} = n\;C^2\,\frac{R + r}{m} + n\,\varepsilon\;C \qquad (f)$$

$$\frac{W_{n\,m}}{W} = \frac{n\;C^2\,\frac{R + r}{m} + n\,\varepsilon\;C}{C^2\;(R + r) + \varepsilon\;C} = \frac{n\;C\,(R + r) + m\,n\,\varepsilon}{m\,[\,C\,(R + r) + \varepsilon]}$$

$$= n\left\{\frac{1}{m} + \left(1 - \frac{1}{m}\right)\frac{\varepsilon}{E}\right\} \qquad (g)$$

From this equation, it is evident that if n is kept constant (say equal to unity) and m be indefinitely increased, $\frac{W_{n\,m}}{W}$ will constantly diminish, the limiting value of the ratio being (with $n = 1$) $\frac{\varepsilon}{E}$, which, with nearly pure metal under treatment will become a very small quantity. The deposit, however, remains the same, depending only upon C.

Take $E = .5$ volt and $\varepsilon = .05$ volt, which conditions may easily be reached, and let $n = 5$ and $m = 9$. Then denoting amounts of deposit in the same time by D and $D_{5,9}$, and keeping C constant,

$$\frac{W_{5,9}}{W} = 5\;\left\{\frac{1}{9} + \left(1 = \frac{1}{9}\right) \times \frac{1}{10}\right\}\;;\text{ or,}$$

$$\left.\begin{aligned}\frac{W_{5,9}}{W} &= 1,\\[1ex] \frac{D_{5,9}}{D} &= 5,\end{aligned}\right\} \qquad (h)$$

Thus, while we have increased the rate of deposit fivefold, the power remains constant.

Of course all of the foregoing leaves out of account the question of loss in the conductors. In the citation of a practical case, in the previous articles, the reference must be to some other form of plant than one for copper refining. For, if n equals 100 and the vats be arranged in n series of n vats, as stated, the total number of vats will be 10,000 (not 1,000), and, if the reference is to a case of electric refining of copper, this plant would contain a greater capacity than that of all of the electric copper refineries in the United States put together. In commercial practice the size of the vats is determined by practical considerations (such as ease of manipulation of plates, not too frequent renewal of plates, economy of total cost of vats for a given anode surface, etc.), as well as by theoretical considerations. Taking the production per vat per hour as 1½ pounds, which is not a large estimate, 10,000 vats would supply 360,000 pounds of pure copper per day.

Cases are mentioned in the former articles of good deposits with 5 volts per cell and with a current density of 200 amperes per square foot. I do not doubt the possibility of obtaining such results in electro-deposition with pure anodes; but in refining copper containing the impurities usually met with, I fear that such practice would prove disastrous to the purity of the deposit. A high electromotive force at the terminals of the vat is of course also to be avoided on account of the losses due to decomposition of water. Cases may however arise, for example, in the refining of gold alloys, when the value of the metal in the vats will overbalance all other considerations in the laying out of the plant.

One very prominent point has not yet been touched upon at all—the source of the energy—the electric generator.

By increasing the number of vats in squares and arranging them electrically in squares, how is the generator affected?

Take, for example, a good sized plant of 100 vats, each vat producing 1¼ pounds of refined copper per hour. Each vat would require 385 × 1¼ amperes = 480 amperes. Should the vats be arranged in a square, there would be required a generator of about 48 kilowatts capacity, giving 4,800 amperes at somewhere in the neighborhood of 10 volts, more or less, depending upon the resistances of the vats and of the conductors. Such a machine would give rise to no end of trouble. It would cost enormously in proportion to its capacity, and in order to be able to run 24 hours per day steadily, it would have to be much larger than the above capacity; every imperfect connection would be an example of an electric heater and cause a large loss, while the expense for conductors would be great.

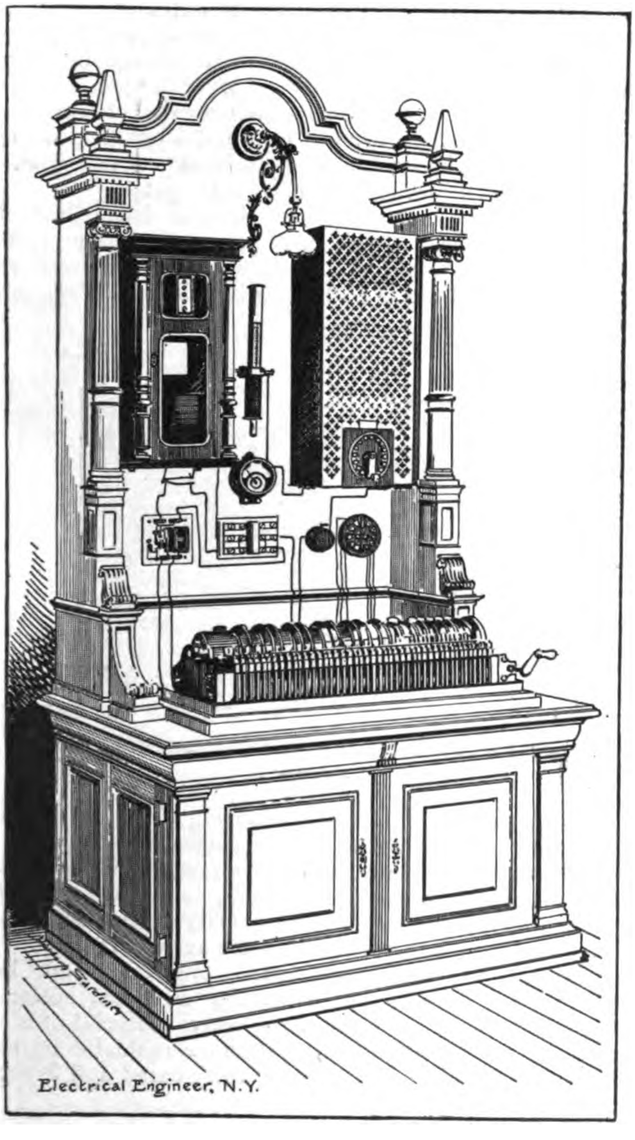

Electrical Engineer, N.Y.

Fig. 1.—Switch Board of Telegraph Storage Battery Plant, Berlin, Germany.

Now suppose these 100 vats arranged in series. The generator would have to supply 480 amperes at somewhere about 75 volts. This machine can be bought from stock at standard prices; a bad connection will not cause the great loss that it did before, and there will result a great saving in copper conductors. In short, we shall have a practical system. Leakage is the limiting condition in the matter of voltages, but in a properly constructed plant, in spite of large vats of liquor and creeping salts, no trouble will result from this cause at the above moderate voltage.

STORAGE BATTERIES IN THE MAIN TELEGRAPH OFFICE AT BERLIN.

As far back as October, 1889, the first attempts to operate their lines with current derived from storage batteries was undertaken by the electricians of the German government telegraphs. The results obtained were so satisfactory that the plant has now been considerably enlarged, so that at the present time 237 circuits are operated by this method. Of these 93 are employed for the Hughes printing lines, 53 being overhead and 40 underground; and 144 operating the Morse system, of which 130 are overhead and 14 underground.

The accumulator employed at the present time is placed in the cellar of the main building and is arranged in four rows of 40 cells each. Each group of 40 cells constitutes a battery by itself, the circuits of which lead independently to the switch-board in the main office. The cells contain 3 positive and 4 negative plates each, and have a capacity of 52 ampere hours and can be discharged at the rate of 10 amperes. In the operation of the cells two groups are always operated in series, while the third is held in reserve or can be charged at the same time. In consequence, arrangements had to be made by which it was possible to cut out each group and to substitute therefor the reserve battery, and in order to effect this without interruption to the service, the reserve battery has to be placed first in parallel with the battery which it is to replace and the latter then cut out of circuit.

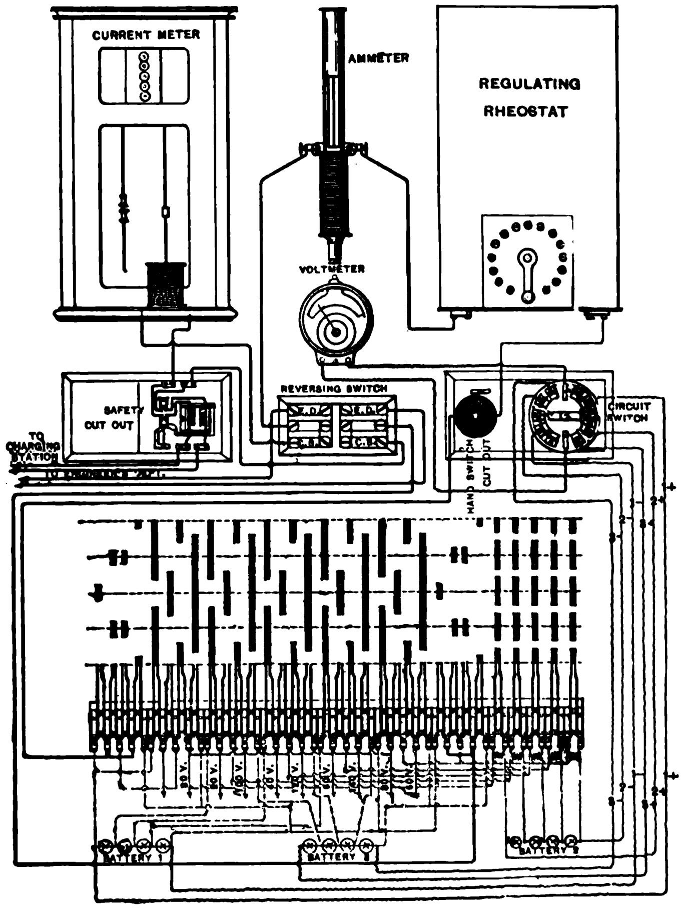


Fig. 2.—Diagram of Telegraph Storage Battery Plant, Berlin, Germany.

The manner in which this was accomplished will be understood from the accompanying illustration. The entire switching for this purpose is accomplished by means of a cylinder provided with contacts which make connections with clips, as illustrated in Fig. 2, which shows the arrangement of the contacts on the cylinder developed as a flat surface. The cylinder is operated by means of a crank and worm wheel, shown in Fig. 1, which represents the entire installation at the main office.

As will be seen in the diagram, Fig. 2, current for charging the batteries is obtained both from the dynamo in the telegraph office in the engineer's department and also from the central station situated at some distance from the telegraph office. The circuits lead first into a safety cut-out which is so arranged that if the current exceeds 12 amperes the circuit is broken. From this point the current passes through an electric meter of the Aron type to a switch with six segments, designated as C S; by means of the bridge pieces the latter are connected with the storage battery S B. From this point the charging circuits lead to the ammeter, to the regulating rheostat, to the hand switch, and to the corresponding terminals of the main cylinder switch. To the blocks marked E D of the switch two wires are connected which lead to the engineer's department, so that by connecting the bridge pieces to the segment marked E D, the charging current is obtained from the engineer's department. The voltmeter is so arranged that by means of a switch it can be connected to any of the three battery groups.

In the lower part of the diagram, Fig. 1, there are shown a number of circuits marked 80, 20, 100 volts, etc. The object of these circuits is to take current of the designated E. M. F. from the cylinder switch. They lead to heavy brass contacts and are connected to the German silver resistances placed in circuit with the battery switch. The resistances are so arranged that for every volt E. M. F. one ohm of resistance is included in the circuit. Thus a circuit requiring an E. M. F. of 160 volts has 160 ohms included in it. The arrangement is such that each underground circuit has its special safety resistance, while not to exceed 5 overhead lines are joined to a single safety resistance. By this arrangement if a short circuit should take place between the cylinder switch and the battery switch, the current could never exceed one ampere, and if such a short circuit takes place an alarm is immediately set in action. This alarm is given as follows: In the earth connection there is inserted a resistance of .5 ohm, and as a shunt to this a polarized Siemens relay with its coils in parallel. The tongue of the relay is not affected by even the heaviest telegraph currents, but a current of .5 to 1 ampere brings the tongue in operation and sets the alarm off. Although no occasion has yet arisen in which this alarm was given, it is nevertheless tested every morning to see whether it is in working order.

Experiments have shown that with the 237 circuits connected, the mean strength of the current varies between .2 and .3 amperes, which would give about .001 ampere per circuit, which agrees very well with former experiments. The small quantity of current required shows that even the smallest sizes of storage batteries required for electric lighting are far too large for telegraphic purposes, and that smaller and simpler cells are quite sufficient, in consequence of which the German telegraph department has undertaken the construction of a special telegraph storage battery. Continued experiments have shown that during ten days' operation the potential of the battery does not drop more than 2½ to 3 volts.

POLICE TO BE USED AS LINEMEN.

In view of the recent destruction of the police telegraph wires in New York by the storm, and the difficulty experienced in securing a force of linemen, the captains of the various precincts will be asked to find out and enroll the men in their squads who may be serviceable for such duty in future emergencies.

Juvenile Labor in Electricity.—The New York State factory inspector, Mr. James Connolly, recommends in his annual report that children under 14 years of age be prohibited from employment in mercantile houses, telegraph, telephone and messenger service.

THE ERNST STORAGE BATTERY SYSTEM.

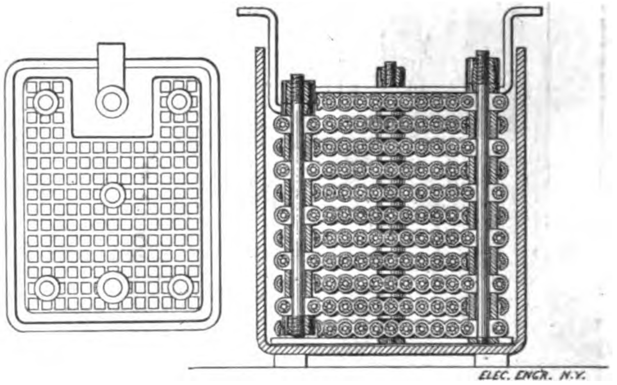
BY

Victor H. Ernst.

Among electricians there is no topic of greater importance than the development of a practical storage system. Such a system would prove of incalculable advantage in electric lighting plants, in the propulsion of street cars and boats, and for numerous other purposes.

The intercirculatory storage battery system, devised by me, is the result of long mechanical experience, enabling me to grasp the difficulties of other systems, and to remedy them in this. The present electrical storage inventions mark, I believe, as great an advance over the present types, as did the triple expansion engine over the old-fashioned slide valve engine. A series of tests and a practical demonstration prove that a gain of at least 20 per cent. in effective power is accomplished by this system.

The numerous experiments of the past decade have demonstrated the uses to which a practical storage system may be put. Heretofore a surface action only has been obtained, one of the greatest difficulties being the retaining of the active material in place during the charging and discharging, and in spite of the concussions incident to use. To this end, plates of various forms have been constructed, having projections, hooks, loops, cavities, etc., but such forms are liable to be quickly destroyed, or else to lack electrical penetration into the active material.



Figs. 1 and 2.—The Ernst Intercirculating Storage Battery System.

Previous to my work little progress had been made toward storing and receiving electrical action by utilizing the inner particles of the active material of a battery plate. In this respect this system is a radical departure, all the material in the plate being fully cured and brought into action.

The system practically combines two fundamental principles involving an absorbent core, having an expansive action. The expansive core of asbestos or other material employed, ramifies through the interior of the active material in such a manner that the active material is kept in close contact with the walls of the plate, giving perfect electrical connections or continuity.

This elastic, expansive and contractile core presents a yielding surface to the active material, so that sudden concussions, as in street-car service, do not crack and dislodge it from the walls of the plate. The absorbent action is also obtained through the medium of the expansible core. As will be seen from the accompanying illustrations, Figs. 1 and 2, the plates are arranged horizontally, with distance washers and rubber bolts, but no lead burning, or soldering of any kind enters into the construction of the cell. The electrolyte circulates by absorption within the active material of the plate, thoroughly curing it in the beginni and leaving it in the best possible condition for receiving and giving out electrical charges.

Owing to the intercirculating action of the electrolyte upon every particle of the active material, it is evident that the main object of a storage system has been attained, namely, the quick preparation of the plates for their work, and their superior efficiency for practical purposes.

It has been found that in a set of 26 cells in use over 18 months, not a bend nor buckle has taken place, nor has any active material become dislodged, which is due to the equalizing action of the asbestos cord during the expansion and contraction of the active materials.

THE REED ELECTRIC RAILWAY SYSTEM.

Among the many workers in the field of electric railway construction, is Mr. E. M. Reed, of Pueblo, Col., who has devised a system in which the trolleys, while operating in essentially the same manner as in the overhead system, are attached to a carriage traveling in a large conduit beneath the surface of the street.

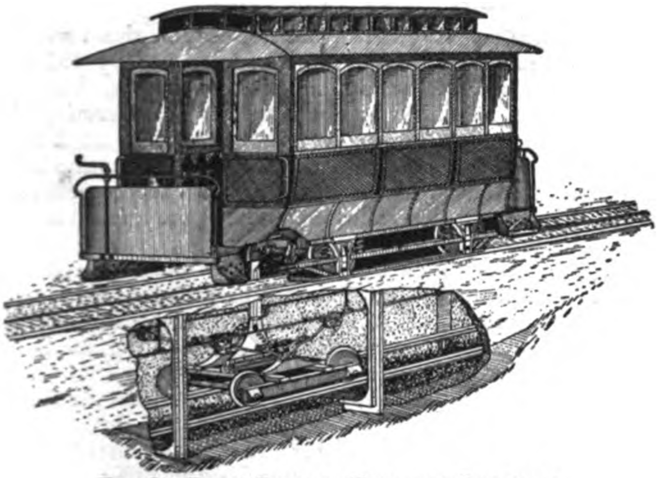


FIG. 3.—REED CONDUIT ELECTRIC RAILWAY.

In the accompanying illustrations, Fig. 1 shows one of the yokes which form the frame work for supporting the concrete walls of the conduit, the upper side portions of these yokes being provided with seats upon which are secured the surface rails. The positive and negative conductors are shown one, on either side of the conduit. These consist of sections of tubing, corresponding in length to the distance between the hangers, where they are sleeved to allow for contraction or expansion due to changes of temperature. They are designed to conduct a current of warm, dry air, which may be forced in at the ends, or at stations along the line, so as to maintain the insulation perfect. At the base of the yoke are seen the rails on which the trolley carriage runs.

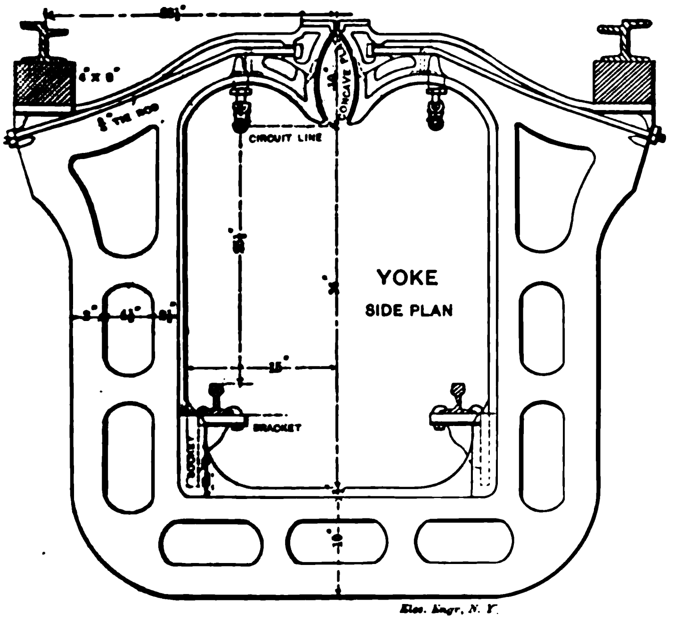


FIG. 1.—REED UNDERGROUND TROLLEY CARRIAGE.

The carriage shown in Fig. 2, consists of a frame mounted on four wheels, which run on the tracks in the conduit. The trolley arms are slightly flexible, and each pair is connected by means of a rod, for the purpose of regulating the pressure of the wheels upon the circuit lines.

In the centre of the carriage will be seen a column, secured to the base plate by means of a hinge, which allows it to tip slightly, and extending up through the surface slot to the motor truck, with which it engages by means of a hinged socket secured to one of the axles. The socket is of sufficient depth to permit a limited play of the column, in case of the car passing over an obstruction. The socket may be raised, and the trolley carriage disconnected, by means of the segments and lever shown.

Fig. 3 gives a view of the conduit, the side being cut away to show the trolley carriage and the means of attaching it to the motor.

The operating expenses of this system when complete are claimed by Mr. Reed to be much less than those of the overhead. A plan is now on foot for the adoption of this system in one of the largest Western cities.

IMPROVEMENTS IN COPPER SMELTING.[1]

Mr. Gilchrist, who, in conjunction with the late Mr. Thomas, developed the basic process in its application to the production of iron, has recently devoted his attention to the smelting of copper, with a view to the elimination of its impurities by similar means. Mr. Gilchrist points out the difference in importance of the application to the two metals, and the results expected from the application of his improved process to copper are rather increased yields than greater purity. It seems likely that both these desirable results may be attained, according to the views expressed at a recent meeting of the London section of the Society of Chemical Industry. It is stated that some enterprising smelters, being satisfied with the prospects, have taken the matter up, and are making the necessary alterations in their furnaces to enable experiments to be conducted on a large scale. The electrical industries are so largely interested in the cheaper production of copper that we hope to learn in due time of the success of the experiments, even though the improvements should be but slight.

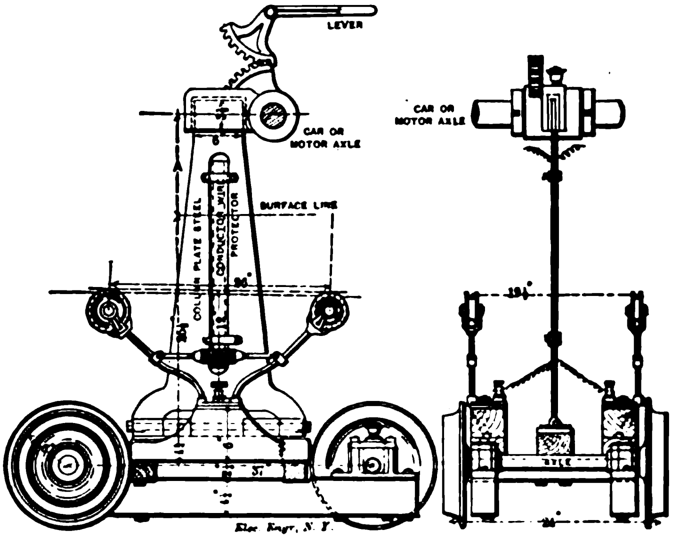


FIG. 2.—REED CONDUIT.

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[1] London *Electrical Review*.

A SIMPLE METHOD OF DYNAMO DESIGN.—II.

BY

Thorburn Reid.

(*Conclusion.*)

Suppose a dynamo is constructed by means of Kapp's formula and it is found that the voltage is too low, as will generally be the case. Then the magnetic resistance is too high somewhere, either in the armature, field or air space. Nothing is known as to the degree of saturation of the iron in field or armature, and Kapp's formula does not give us the true resistance either in field, armature or air space. Of course this difficulty might be obviated by simply increasing the number of ampere-turns on the field, but this means added expenditure for copper and possibly more loss of energy. The cross section of the field core might be enlarged, but the armature core might be near saturation, and thus this decrease in the field resistance would not proportionately increase the flux through the armature. The same is true in regard to increasing the cross section of the armature; the field might be too near saturation.

In short, Kapp's formula merely expresses the flux through the circuit as a whole and does not at all show the effect of each part. In the second place, different sizes and types of dynamos are seldom worked with the same degree of saturation and thus a new constant has to be determined for each size or type of machine. The table of constants given on page 121 (second edition), would be fairly accurate if the initial permeability of the iron were 940 and his constant for air correct, and the field magnets of wrought iron. Finally, for cast iron field magnets Kapp's formula is generally nowhere near correct. The number of ampere-turns obtained by means of it has often to be multiplied by 2 or 3, sometimes even by 4 or 5. In such cases it would be just about as accurate to guess at the number of ampere-turns and estimate the proper number by the voltage obtained.

"My friend," remarks our practical man, "I see your point very clearly. These are serious objections to Kapp's formula, but that formula has been of incalculable benefit to me in my work and I do not propose to give it up till I can get a better."

Very well, you have one ready to your hand, if you will only take the trouble to look into it, which is far superior to Kapp's.

In the year following that in which Kapp communicated his formula to electricians, Drs. J. and E. Hopkinson published an account of some experimental investigations made with the help of a formula which was practically that of Kapp, as stated by him originally. They, however, applied the formula more logically, only changing the method of application. Instead of obtaining the magnetic resistance in the different parts of the circuit, they deduced the E. M. F. required to drive the necessary number of lines through the magnetic resistance in the different parts of the circuit. Their test was made with an actual machine already built and their object was, as stated, to obtain the relation between the E. M. F. required and the E. M. F. delivered from theoretical considerations, and then to compare this with the true relation obtained experimentally. The primary object of their investigation was not, therefore, the designing of dynamos; but their method, as they no doubt foresaw, is an excellent one for the purpose.

Without entering further into the experiments of Drs. J. and E. Hopkinson, I will attempt to give a clear and simple outline of a method which is a modification of theirs, and which I have found very convenient in designing dynamos and other magneto-electric machines, partly on account of its ease and rapidity of application, partly for the reason that it shows very clearly the condition of affairs in the different parts of the circuit; but mainly on account of its accuracy.

The method, of course, presupposes a determination of the saturation curves of the metals used in the different parts of the circuit. At this point the practical man inquires, "How am I going to make such a determination, which requires the most delicate instruments to be set up in a place where they shall be entirely free from all disturbing influences in a factory where the floors are shaking and masses of iron are always being moved about and disturbing currents are everywhere?" I answer from bitter experience that you can not do it. But why try? There are numbers of laboratories throughout the country, at colleges and elsewhere, where such determinations can be made with the greatest ease. The instruments are all there, and the disturbing elements lacking. The samples of metals need not weigh more than a few pounds, and can be easily tranferred. The expense would be as nothing, compared with the benefits accruing, and would doubtless be repaid in a very few months.

Experience has taught me that not only is the variation of the magnetic properties of iron furnished by different makers very much less than one would suppose, but also that the iron furnished by one company at different times is remarkably uniform, the largest variation that I have yet found in the whole magnetic circuit of a dynamo being less than 5%; that variation including also the inaccuracies in the preliminary determination, and in the measurements and workmanship of the machines.

I carried through a set of experiments on the cast iron and steel used in the dynamos of a certain company, some time ago, to determine their saturation curves. The method of experiment was a very simple one, enabling me to get a complete saturation curve in an hour or two. There were no very delicate adjustments, and the apparatus used could be found in any scientific laboratory. The data having been obtained, the curves were carefully plotted out on section paper. The accompanying diagram, Fig. 1, shows the method of arrangement of the curves, the data for which were taken from Hopkinson's paper printed in the *Transactions* of the Royal Society of the year 1885, part second.

The vertical scale represents C. G. S. lines per square inch for every curve and line on the plate. The first horizontal scale represents ampere-turns per inch in length of the magnetic circuit for wrought and cast iron. For convenience in locating the air line, the same scale was made to represent ampere-turns per one-hundredth of an inch in length of the magnetic circuit.

The second scale belongs to the two curves of permeability of wrought and cast iron, and gives the actual numerical value of the permeability. The third scale is used in connection with the line marked "C. G. S. lines per square centimetre," and furnishes a ready means of transforming from C. G. S. lines per square centimetre to C. G. S. lines per square inch, or vice versa. The last scale is used in the same way to transform from Kapp lines per square inch to C. G. S. lines per square inch, and vice versa.

To explain the use of the last two scales, first, suppose we want to find out how many C. G. S. lines per square inch correspond to 13,000 lines per square centimetre. Finding 13,000 on the third scale, and following the vertical ordinate to its intersection with the "C. G. S. lines-per-square-centimetre" line, we read on the vertical scale 84,000 lines per square inch. We can then, if we wish, reduce to Kapp lines per square inch by means of the dotted line, the intersection of 84,000 C. G. S. lines per square inch with the dotted line giving us 14 Kapp lines per square inch. Thus our original 13,000 C. G. S. lines per square centimetre are equivalent to 84,000 C. G. S. lines per square inch, or to 14 kapp lines per square inch. This affords us a means of reducing C. G. S. lines per square centimetre or Kapp lines per square inch to C. G. S lines per square inch.

Now to obtain the ampere-turns, find on the vertical scale the number of C. G. S. lines per square inch you intend to use, obtain its intersection with the saturation curve of the substance in the magnetic circuit, then on the horizontal scale read the number of ampere-turns per inch in length of the magnetic circuit, multiply this number by the length of the magnetic circuit in inches, and you have the total number of ampere-turns required. If the substance in the magnetic circuit be air, you must first multiply the number of ampere-turns obtained from the scale by 100.

The use of these curves in designing dynamos is just as simple. Suppose, for instance, that we know the length and cross section of the different parts of the magnetic circuit of the dynamo in inches, the total number of lines that must traverse the armature to give the requisite E. M. F., and the leakage coefficient. First divide the total number of lines traversing the armature by its cross section. To obtain the number of lines per square inch, from the curves, obtain the ampere-turns per inch and multiply by the diameter of the armature. We thus get the number of ampere-turns required to force the total number of lines through the armature. Next, divide the total number of lines by the cross section of the air space. Find the ampere-hours per inch in length from the curve and multiply by 100 times the double depth of the air space, the length of the air magnetic circuit being twice the clearance between the armature core and the surface of the field poles. The result is the number of ampere-turns required to force the total number of lines through the air space.

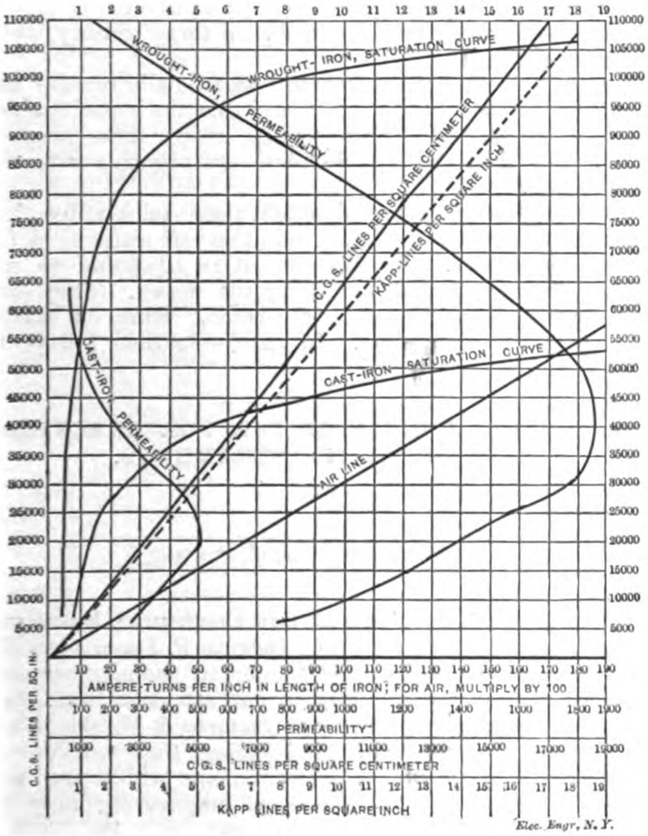

Fig. 1.—Magnetic Curves For Iron and Air.

Next multiply the total mumber of lines by the leakage coefficient, which is the ratio of the number of lines traversing the field to those traversing the armature. This gives us the total number of lines traversing the field magnets. Divide by the cross section of the field to obtain the C. G. S. lines per square inch. From the curves obtain the ampere-turns per inch in length. Multiply by the length of the field circuit in inches and you have the number of ampere-turns required to force the requisite number of lines through the field. Finally add together the ampere-turns thus obtained for the armature air space and field, and you have the total number of ampere-turns required for the dynamo.

Now as to the leakage coefficient, its value will depend on the ratio of the magnetic resistance of the path offered to the lines of force *around* the armature, to that of the path offered *through* the armature. As long as the armature magnetization is not carried up to saturation, this ratio will be fairly constant. Of course, its value will vary somewhat for different types of field, depending on the paths offered for leakage, but as far as I have been able to discover, its value in single horse-shoe magnets varies very little from 1.3. It is possible to determine it very accurately from a theoretical investigation, but that is very tedious, and it may be more easily determined by trial on an actual machine. Once determined for one type of machine, it is good for all the sizes of that type, unless the saturation of the armature is very much changed.

I tested the accuracy of the curves which I obtained as a result of the experiments I made, by calculating the number of ampere-turns required by a number of machines ranging from ½ h. p. up to 80 h. p. and found that my results differed from the actual number required by less than 5 per cent. in all cases where the records were reliable.

Another characteristic of this method which I have not dwelt on is the clearness with which it shows forth the condition of affairs in the different parts of the circuit. Kapp's formula does not give the true resistance in any part of the magnetic circuit, and therefore, if formula and fact do not agree, there is no way of knowing just where to look for the cause of the discrepancy. The method described here gives the ampere-turns for each part of the circuit and makes it much easier to determine where to look for the disturbing element.

Below is given an example of the application of the method to the Edison-Hopkinson machine described in the London *Electrician* for 1886, page 39, and following. All the dimensions of the machine were first reduced to inches and are given below :

Edison-Hopkinson Machine.

Total number of lines through the armature, 10,850,000.
Coefficient of leakage, 1.32.
Total number of lines through the field, 14,322,000.

	Length.	Area.	Lines per sq. in.	Turns per in. in length	Total turns.
Armature......	10.1	125.6	86,500	31	318
Air Space.......	1.2	234	48,400	13,800	16,560
Limbs...........	.36	144	99,400	76	2,736
Yoke	19.35	174	82,300	25	484
Poles	4.4	191	75,000	19	84
Total...					20,177

Actual number of ampere turns, 19,560.

Percentage of calculated to actual, 103 per cent. That is, the calculated is 3 per cent. higher than the actual number found in practice.

The numbers in the third column are found by dividing the total number of lines traversing the part in question by its cross section. The fourth column is obtained from the third by means of the curves. The numbers in the fifth column are obtained by multiplying those in the fourth by the lengths of the magnetic circuits, and the total number of turns is the sum of all the numbers in the fifth column. I should like to give the figures on some of the machines by which I tested my curves, but the companies which kindly furnish me data, were unwilling to have those data published.

I do not propose at present to enter into all the applications of these curves, as they will readily present themselves, as, for instance, compounding and other methods of regulation.

In his last annual report on the Chicago City Railway, Mr. C. B. Holmes says that the operating expenses per horse car mile were 21.985 cents, and per cable car mile 9.650 cents. The company ran 12,740,480 cable car miles, and 4,859,200 horse car miles. The cost of repairs per car was $71.40. The company lost 1 in 20 of its horses by death.

ON A SIMPLE EXPERIMENTAL STORAGE BATTERY.

BY

Harry E. Dey.

I FIND that a great many so-called practical electricians are quite ignorant in regard to storage batteries and the principles upon which they are based. Most of them are anxious to learn, but have not the opportunity, and few books deal with the subject in a way to be understood, especially by those who have not had a technical education.

There is much to learn that can be taught only by experience, but I will endeavor to give the information derived from two and a half years of constant experimenting.

I should advise any one intending to experiment in this field, to commence by making a small Planté battery. It can be made at a cost of considerably less than one dollar, and will be found quite useful afterwards for any purpose where a constant E. M. F. is desired, or a heavy current needed for a short time. The one I am about to describe will quickly melt a No. 18 B. &'S. copper wire, and has a capacity of 3 ampere-hours, with an E. M. F. of 2 volts.

I shall begin by first explaining the principles on which the storage battery operates.

If a strip of platinum is attached to each of the two terminals of a battery and dipped into acidulated water, bubbles of gas will arise from each; oxygen coming from the positive, or that plate which is connected to the carbon, and hydrogen from the negative.

Now, if in place of platinum we use zinc, or any metal that will dissolve in the acid, the oxygen will combine with the zinc, and dissolve, forming sulphate of zinc. The hydrogen will escape, as in the first experiment, until enough zinc is dissolved to form a plating solution. The negative electrode then plates with zinc, and the hydrogen goes into the liquid to take the place of the zinc.

For a third experiment we will use two electrodes of sheet lead which will not dissolve in the acid. The oxygen enters into combination with the lead, and, as it is insoluble, does not leave the plate, but forms a thin coating of dark brown or black peroxide of lead on the surface. As the hydrogen has nothing with which to combine, it is given off freely in bubbles from the negative plate. After the positive plate is well coated with peroxide, reverse the direction of the charging current, and the negative (now positive) plate will become coated with peroxide and the hydrogen formed at the other plate will combine with the oxygen of the coating and form water, leaving the surface in a finely divided or spongy state. If tested now, it will be found to give a small current of electricity, having 2 volts E. M. F., but lasting only for a very short time. This can be greatly increased by charging and discharging many times, occasionally charging up in the reverse direction. In discharging, the finely-divided or spongy lead is attacked by the acid in the same manner as the zinc in a primary battery, of which it practically takes the place; the peroxide, which is one of the best of electro-negative elements, corresponding to the carbon or copper. A storage battery, when charged, is practically a primarybattery in its discharge action.

Now that we have the principles, let us endeavor to make a practical Planté battery. Out of a piece of $\frac{1}{16}$ (3 lbs. per foot) sheet lead cut 21 pieces, each 4 inches square, with a projecting end or lug for connection at one corner, ¾ of an inch in height, and ½ inch wide.

Procure 30 rubber bands one-eighth inch thick. If not convenient to obtain, they may be sliced from a piece of soft rubber hose containing no fibre. Place three of these on each of ten plates perpendicularly, one in the centre and one at each edge. These are to be the positive plates. Place all the plates together alternately, negative and positive, the bands separating them. Let the connections of one set be all on one side, and those of the other at the other side. Stretch a few bands around the plates, to clamp them together. Cut in a board, or mold in clay, two grooves ¾ inch wide, ½ deep, 8 inches long, and 2¼ inches apart, placing one four inches in advance of the other. Stand the plates on end, so that the lugs form feet standing in the grooves. Pour into the groove very hot lead to a depth of ¼ inch. They are now ready to place in the acid.

Take a jar containing about a quart of water, and pour in *very slowly*, stirring at the same time, two pounds of sulphuric acid, making it 1.2 specific gravity or 25° Beaume.

Place the plates in a suitable jar, and after the acid is cool, pour in enough to cover them. Connect the intended positive plates with the positive wire of a suitable charging current, remembering that the positive current from a primary battery comes from the carbon or copper plate, and the negative to the negative wire. The charging current should be nearly three volts; consequently it will require two bichromate of potash, or three gravity cells connected in series.

Charge and discharge often and occasionally reverse the charging current until it is found that the capacity does not increase. It will probably be about three ampere hours. See that the outside plates are negative with the final charge.

The plates may be formed much more quickly by first soaking in a fifty per cent. solution of nitric acid for twenty-four hours. In this case it is advisable to use thicker lead, five pounds not being too heavy. They can then be soaked nearly forty-eight hours. Rinse off before placing in the electrolyte. In another article I hope to treat of red lead batteries.

THE TORSION GALVANOMETER FOR PRACTICAL ELECTRICAL MEASUREMENTS.

BY

F. Uppenborn

IN the December 24 issue of THE ELECTRICAL ENGINEER there appears an article by Mr. Osborn P. Loomis on the application of the Weston voltmeter to the measurement of resistances. I would like to call attention to the fact that the torsion galvanometer of Siemens & Halske is better adapted to this class of measurements than the Weston voltmeter. All electrical measurements which are met with in the practice of electrical engineering may be carried out in the most exact manner with the torsion galvanometer.

The application of the latter to the measurement of insulation resistances was proposed by me as early as 1888 in the *Centralblatt für Elektrotechnik.* In this methods insulation resistances from a short circuit up to 100,000 ohms can be measured, according to the difference of potential employed. Very small resistance can also be determined with the aid of this instrument. It will also measure differences of potential from .001 up to 1,700 volts; currents from .001 up to 100 amperes, and more.

According to my judgment the torsion galvanometer is the most convenient and accurate measuring instrument which can be used in practice. I could never conceive why the instrument should be so little used abroad, and that many writers on electrical subjects treat of it in a very off-hand manner, or do not mention it at all. I would refer those interested in the application of the torsion galvanometer, for the measuring of resistances to an article appearing in the *Centralblatt für Elektrotechnik*, vol. x, p. 585.

NEW BRITAIN, CONN.—The New Britain Electric Light Co., at its adjourned annual meeting, voted to increase its capital stock from $60,000 to $80,000, the present stockholders to get the preference on the new stock.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XIII.

(*Copyright, The Electrical Engineer.*)

BY

Herbert Laws Webb

TEST FOR CAPACITY.

Fig. 33 shows the connections for taking the discharge of the cable. The cable is connected to the lever of the discharge key, the other connections remaining the same, with the exception that here the second pole of the battery and the second terminal of the galvanometer must necessarily be connected to the earth.

It is usual to charge the cable for 15 seconds by pressing the lever down on the lower contact and keeping it clamped there by means of the trigger, for that time. The trigger is then pulled back, releasing the lever and allowing it to fly up to the upper contact, thereby discharging the cable through the galvanometer to earth.

We will assume that the inductive capacity of a cable half a mile long is to be measured. By means of the plugs a section of .1 microfarad of the condenser is connected to the terminal blocks and the discharge taken with five cells of battery in the manner described. The deflection is 200 divisions of the scale. The cable is connected to the discharge key, and a discharge taken in the same manner. A deflection of 175 divisions is obtained. Now, the deflection of 200 was given by the discharge of a condenser of known capacity; therefore, if we divide the second deflection by the first we shall obtain the capacity of the cable in terms of the capacity of the condenser:

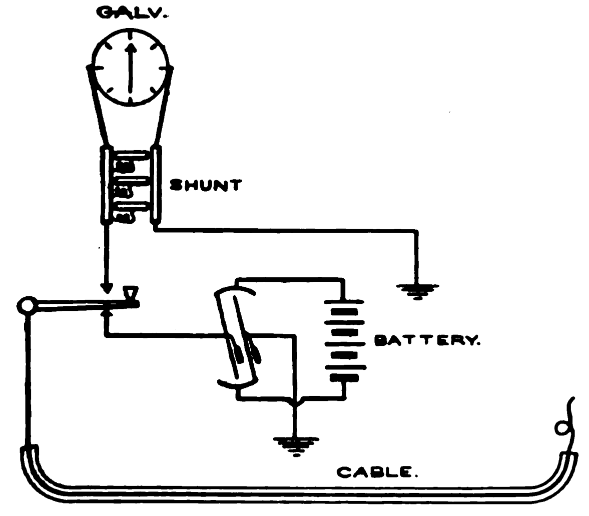

FIG. 33.—CAPACITY TEST, CONNECTIONS FOR CABLE DISCHARGE.

$$\frac{175}{200} = .875.$$

Therefore the capacity of the cable is .875 of the capacity of the condenser. The capacity of the condenser, however, was only .1 of a microfarad; therefore, to obtain the absolute capacity of the cable in microfarads we must multiply the above result by .1:

$$.875 \times .1 = .0875.$$

The absolute capacity of the cable then is .0875 microfarad.

We always need to reduce our results to a definite unit of length and of course need to know the capacity per mile. We have already seen that the insulation resistance decreases with the length of the cable and that the absolute insulation must be multiplied by the length in order to arrive at the insulation per mile. With inductive capacity the reverse is, of course, the case, the capacity of a cable increasing with its length. This is obvious, if we consider a cable as a form of condenser. One mile of a cable has a certain capacity, then two miles of the same cable will have twice the capacity, five miles five times the capacity and so on. Therefore, to determine the capacity per mile, the absolute capacity must be divided by the length. In this case the absolute capacity is .0875 microfarad and the length .5 mile.

$$\frac{.0875}{.5} = .175.$$

Therefore, the inductive capacity per mile of the cable being measured, is .175 microfarad.

The discharge from the condenser is often called the capacity constant, just as the constant of the galvanometer is often called the insulation constant. Neither expression is correct, but if they are used it should always be remembered that in working out a test for capacity the operations performed in working out the insulation are exactly reversed. For insulation, the constant is divided by the cable deflection to obtain the absolute, and, to obtain the insulation per mile, the absolute is multiplied by the length. For capacity the cable deflection is divided by the "constant" to obtain the absolute capacity, and to arrive at the capacity per mile, the absolute is divided by the length.

It must always be borne in mind that in dividing the discharge of the cable by the discharge of the condenser the result obtained is in terms of the capacity of the condenser employed. If a condenser of 1 microfarad capacity is used, the result will be in microfarads, but if the capacity of the condenser is $\frac{1}{3}$, $\frac{1}{10}$ or $\frac{1}{20}$ of a microfarad the result must be divided by 3, 10, or 20, as the case may be, in order to determine the capacity of the wire or cable in microfarads. Supposing a condenser of $\frac{1}{3}$ microfarad were used and gave a discharge of 120, and the cable gave a discharge of 150; then the capacity of the cable would be

$$\frac{150}{120} + 3 = .4166 \text{ microfarads.}$$

If the cable were 1.5 mile long, then the capacity per mile would be

$$\frac{.4166}{1.5} = .277 \text{ microfarad.}$$

If we were to use a condenser of .05 microfarad capacity, and obtained a discharge of 75, and from the cable one of 100, then the absolute capacity of the cable would be

$$\frac{100}{75} + 20 = .0666.$$

Supposing the cable to be 2,165 ft. long, or .41 of a mile; then the capacity per mile would be

$$\frac{.0666}{.41} = .1624 \text{ microfarad.}$$

When a number of wires are to be tested for capacity it is best to multiply the discharge from the condenser by the quotient of the value of the condenser, divided into one, which will give the discharge that would be obtained from a condenser of one microfarad capacity. Then dividing the discharges of the wires by this figure will give the absolute capacities directly in fractions of a microfarad.

If the condenser is adjusted to a capacity of .05 microfarad and gives a discharge of 75, by multiplying this discharge by 20, $\left(\frac{1}{.05}\right)$, we obtain 1,500, which is the discharge that a condenser of 1 microfarad would give with the same conditions of battery-power and galvanometer. Then by dividing the discharge deflections of the wires by 1,500 we obtain their capacities in fractions of a microfarad. This will be found more quickly than dividing in each case by the condenser discharge, and again by the capacity of the condenser.

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Matter is indestructible, and is measured by weight; energy is indestructible, and is measured by work; intelligence is indestructible and is measured by adaptation.—Josiah Parsons Cooke.

ELECTRIC RAPID TRANSIT FOR NEW YORK.

THE ease with which the Rapid Transit bill was passed by the Legislature of this State was a striking exemplification of the degree to which the importance of the question has been realized. Over any ordinary measure, there would have been the usual amount of delay from one cause or another, and nobody would have been held particularly to blame. But in this case, the needs of the city and the people were so apparent that to trifle with them became dangerous work, and no politician cares to run counter to the popular will for a very long time after he has satisfied himself as to what the popular will is. Now if there is one thing upon which the public resolve is set, it is to get better transportation between the heart of the city and the suburbs. The movement is largely based upon the individual desire for greater speed and convenience in travel, but it affects larger issues, and touches the very welfare of the State as well as the future position and prosperity of this great city of New York.

The Rapid Transit law is broad and liberal, and under its provisions the Rapid Transit Commissioners should be able to confer great boons on the community. It permits the extension, as we understand it, of present facilities, and there is no good reason why concessions should not be made to the Elevated Railroad such as will tend to the advantage of the passengers over it. But the chief concern, of course, is with the new facilities to be created, and it is here that the electrical engineer perceives his legitimate opportunity. With electric traction in its present advanced state, handling a business in this country of 500,000,000 passengers per year, he knows that the resources of his art are equal to every demand or strain that the very best system of rapid transit can put upon them. The success of the underground electric road in London, which is already working to its full capacity and is to be greatly developed and extended, shows that here in New York, if we will, we can leave all the old methods behind at one stride, and secure the ends after which the city has yearned in vain these fifty years.

THE STORAGE BATTERY IN TELEGRAPH AND TELEPHONE WORK.

ALTHOUGH the primary battery in the shape, principally, of the gravity and other forms of the Daniell cell still holds its own as the source of current for the operation of telegraphs, signs are not wanting to indicate that for the larger telegraph offices at least the days of the battery are numbered. It is now more than fifteen years ago that the Western Union Company introduced the dynamo to operate a large number of its circuits centering in this city, and of late it has extended this practice by similar installations in Albany, Pittsburgh and Chicago. The reduction in the number of cells effected by this change amounts, as may be readily calculated, to many thousands, involving not only a large saving in room, but also in expense of maintenance. In contrast to this it is interesting to note that, abroad, the use of the storage battery seems to be looked upon with more favor in this class of work than the application of the dynamo direct. The success here attained with the latter goes to indicate that so far as steadiness of current is concerned little is left to be desired in any respect, and the foreign arrrngement with storage batteries may be looked upon as the outcome of a more conservative, not to say timid, management. Thus far we believe no instance is on record in which the source of current from dynamos has failed in this country, especially as all the arrangements are in duplicate to guard against break-downs; and it will be recalled that during the recent fire in the Western Union Building, notwithstanding the total destruction of all the batteries, the dynamos were maintained in continuous operation throughout, thus affording the company an incalculable benefit. In the arrangements adopted in Berlin, which we describe in this issue, the storage battery is evidently doing excellent work, and its use will without doubt be extended there. As our readers may be aware, storage batteries have been in use for some time in the General Post Office in London, their use having been early advocated by Mr. William H. Preece. The low internal resistance of the cells makes them admirably adapted for operating a large number of circuits and for this reason they are peculiarly suited to telephone work where transmitters are placed in multiple. As an example of this our readers will note such an application in the operation of the long distance concerts, a very interesting example of which we describe on another page. In these transmissions very powerful transmitters are employed, which take a current far in excess of that usually employed on short line work and in which the cells are drawn upon to a considerable extent for current.

PRACTICAL TESTING INSTRUMENTS.

The excellent article by Mr. Osborn P. Loomis, published in a recent issue of The Electrical Engineer, describing the application of the Weston voltmeter to a variety of tests, has called forth a communication from a well-known German electrical engineer, Mr. F. Uppenborn, in which he draws attention to the merits of the torsion galvanometer for practical methods of electrical measurement. While there can be no doubt as to the wider range and sensitiveness of the torsion galvanometer over any type of instrument based on the principle of the Weston voltmeter, it cannot be denied that for many purposes the latter has advantages which the torsion galvanometer does not possess. Principal among these is the great portability of the Weston voltmeter, and the fact that it can be used practically in any position. If to this is added the fact that its sensitiveness is also far greater than that of any similar instrument yet devised, it must be admitted that it occupies a position which it would be difficult to fill by an instrument of the type of the torsion galvanomter, which must be set up in a fixed position, is subject to disturbances by vibration, and requires manipulation in order to obtain the desired reading. In estimating the value of a practical instrument, the qualities of portability and direct reading cannot be overestimated, and when these are taken into consideration the Weston voltmeter must be admitted to occupy a field to a large extent distinct from that to which the torsion galvanometer is applicable.

THE ERNST STORAGE BATTERY.

The ills to which the storage battery is subject may be said to be largely, if not entirely, due to the chemical changes which the active material undergoes during charge and discharge, and which are followed by mechanical changes. Thus it is well known that plates grow during use, and where the arrangement is not such that a certain flexibility is provided for, buckling and other distortions take place. An interesting departure in the construction of such cells is that due to Mr. V. H. Ernst, which we describe elsewhere in this issue, and in which provision has been made for the changes in volume which the active material undergoes. This has been very ingeniously effected by providing the active material with a flexible core which shall at the same time provide a means of affording the solution access to the interior parts of the active material. In the experiments recently made by Prof. Ayrton and his associates, and described in our columns, it was shown that a considerable percentage of the active material in the present form of storage battery remained inactive. It would therefore be interesting to know to what extent an intercirculatory system, such as that of Mr. Ernst, would overcome this difficulty, and we hope a test to determine this point may be made at an early date.

The Electrical Industry Considered Geographically.

One of the most interesting publications that has reached our hands lately is an atlas issued by the Thomson-Houston Company, showing, State by State, the distribution of the various electric lighting and electric railway systems. The work has been about as well done as it could be, and presents may suggestive points for note and study. The Thomson-Houston Company itself has no reason to be ashamed of the exhibit made. Out of a total of 1,985 central station plants of all systems, it has 666, or more than twice as many as its nearest competitor; and out of 240 electric railways it has 103. If to these preponderating figures we add those of its allied and subsidiary systems, it would have a good half in each field of work. It would have been interesting to have with these statistics a financial exhibit of the value of investment that each system represents, as a mere total of plants must necessarily include single stations that weigh against at least a hundred others; but even under this head, the publishers could doubtless hold their own most satisfactorily. As to the general showing of the industry, it may be said that the introduction of electric lights and electric railways is evidently very widespread.

World's Fair—Appointment of Mr. Barrett.

Official announcement is made of the appointment of Mr. John P. Barrett as Chief of the Electrical Department of the Columbian Exhibition. This selection by Director General Davis and the board ensures a vigorous and comprehensive treatment of the electrical part of the industrial exhibit, and a thorough-going execution of the plans adopted for that important part of the World's Fair. Mr. Barrett's energy of character and executive capacity are well known in electrical circles, particularly so in the West, where he has for many years been in charge of the Electric Bureau of the city of Chicago. With the services of an adequate engineering and technical staff, yet to be appointed, Mr. Barrett may be expected to organize and exhibit in 1893 such a display of the arts of electricity as has never been seen before, including a hitherto unexampled employment of electrical means of illumination transmission of power, communication and transit throughout the various grounds and edifices of the fair.

Reminiscent.

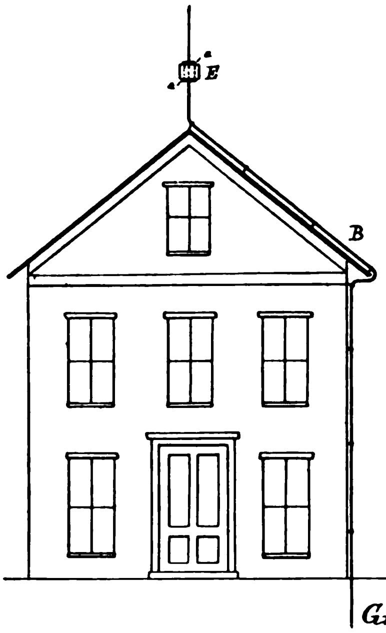
The present generation of telegraphers can scarcely recall a time when, as has been the case during the recent breakdown of communication, messages between New York and Philadelphia have, in default of wires, been sent by train for three or four consecutive days. In the old days such occurrences were not so infrequent as to excite especial comment. In one respect, at least, the modern customs are some small improvement over those which formerly obtained, inasmuch as messages are now accepted, as the receiving clerk suavely informs the customer, "subject to indefinite delay," whereas in ancient days, it might in most instances have been affirmed with entire truth, that the message and the customer were "taken in" simultaneously, for the urbane clerk would never have dreamed of "giving it away" even if the line had been helplessly down for a fortnight. The muse of the immortal Selden once ventured to touch lightly upon this theme; his reflections, as we remember them, ran somewhat thus:—

> Little that indulgent public
>   Guess how they are skinned alive,
> We know better how it's managed;
>   "Package by express at five."

NEW METHOD OF PROTECTING BUILDINGS FROM LIGHTNING.

Heretofore, protection from the destructive effects of lightning has been sought by the use of a metallic conducting rod, which is expected to take up, constantly, whatever excess of electricity there may be in the surrounding atmosphere, whether diffused, or in the form popularly known as a "bolt," and carry it to the earth, where it would be harmlessly dissipated. This method has, in many cases, proved wholly inadequate, buildings so protected having been damaged by lightning.

The accompanying illustration represents a novel type of lightning arrester devised by Mr. Nathaniel D. C. Hodges, in which he makes use of the well-known fact, that the potential of any given quantity of electricity, is dependent upon the surface of the body over which it is forced to spread itself. Thus a given quantity of material in the form of a solid mass, when charged nearly to repletion, will exhibit a very high electromotive force; while, according to Mr. Hodges, if the amount of electricity, and the quantity of material remain the same, but the structure of the material be changed from a solid to a scattered, fine powder or vapor, the potential of the electricity there stored practically disappears.



Hodges' System of Lightning Protection.

The object of Mr. Hodges' invention, therefore, is to take advantage of this property of extended surface present in pulverized substances, and thus, without attempting to lead the electricity away from the threatened building, to place such a substance in the probable path of the current in such manner that the electricity will pass into this substance in preference to attacking the threatened building. In charging this interposed substance, providing the aggregate surface of its parts is sufficiently large, Mr. Hodges claims that the potential of the most violent "bolt" of lightning becomes destroyed, or so greatly reduced that the current will readily be carried off by the rod, or even dissipate itself harmlessly in the surrounding moist air.

In the illustration the box E containing the soot is of thin, non-conducting material, and is interposed in the lightning-rod, B, about six or eight feet above the roof of the building, the rod being broken at that point and connected by means of the fine wires, *a*, so that the electricity can pass from that portion which enters the top of the box, to that which emerges from the bottom, only by passing through the soot. According to Mr. Hodges, as soon as the electricity enters a substance of this structure, its particles fly apart, some or all of them being charged, and thus the potential will be greatly reduced and probably no further harm will result. This effect, of course, would depend largely upon the quantity of soot employed; but a cubic foot, Mr. Hodges asserts, would probably be found sufficient for all ordinary cases.

SPECIFICATIONS FOR WIRING WITH THE "INTERIOR CONDUIT" SYSTEM.

We print below the standard specification form adopted by the Interior Conduit and Insulation Co., for electric light work:—

System.—The building to be thoroughly equipped from the source of supply to each outlet with the insulating conduits of the Interior Conduit and Insulation Co. in such manner as to provide continuous channels or race-ways for the wires. The continuity of each tube employed for this purpose shall be such as would be required if it were to be used for conveying water or gas.

Strict compliance with this requirement will be demanded, since one of the chief advantages of the system, herein specified, is to exclude water and gas from the wires, and therefore afford adequate protection against their deleterious effects.

Accessibility.—To the end that each and every wire may be at all times accessible for inspection, repairs or renewal, the location, sectional division, joining, intermediate and terminal elbowing, the placing of switches, cut-outs and junction boxes and the final emergence of the tube beyond the finished surface at the fixture outlet, must be done in strict compliance with the rules and regulations herein contained.

Appliances.—In order to secure safety, durability and convenience and to give a finished character to the work, all appliances employed shall be such as are designed especially for use in conjunction with this system.

Subdivision of Risers.—The building must be divided into a number of sections, and each section provided with an independent group of risers, thus avoiding the multiplication of elbows, intersection boxes and long runs of the taps or branches. Every conductor in each group of risers must be provided with an independent tube.

Branches.—For all branches the standard "twin conductor" of the Interior Conduit and Insulation Co., requiring but one tube, must be employed. The current limit of the branches must be that fixed by the Fire Underwriters' rules.

Size of Tubes.—All tubes must be of sufficient size to allow the wires to be readily drawn in, withdrawn and reinserted at will. A quarter (¼) inch tube will be permitted only where space is extremely limited, as under a thin plaster finish.

Clips.—Tubes, whether concealed or on the surface, must be held in place by metal "clips;" the use of staples for such purpose will not be allowed where it can be avoided.

Joints.—The tubes must be cut squarely and then reamed out smoothly and the ends joined in the manner and by the use of the corrugated coupling designed for that purpose.

Elbow Limitations.—Where more than four elbows are unavoidable, an intersection box must be inserted to relieve both the wires and the tubes of strain when the wires are being drawn in.

Outlets.—All tubes must emerge at outlets in terminal boxes, thus leaving the outlets so protected as not to be injured by the plasterers.

Fixture Supports.—Where no gas pipe or other support for the fixtures exists, the special form of terminal box designed to furnish such support must be employed, and must be substantially fixed to a suitable foundation in the ceiling or walls.

Junction Boxes.—Main circuit junction boxes, must be placed on each floor in each section; from these junction boxes all branches in that section must ramify.

Cut-Outs.—Standard non-combustible cut-outs must be used within the junction boxes, and each branch wire leading from the same must be protected by a safety fuse.

Floor Work.—To guard against mechanical injury and the destructive action of cement, all floor conduits must be made of double tube, one telescoped within the other and both the outer and inner tubes joined in the usual manner. The outer tube must, in the case of contact with cement, be alkali proof. As a further protection, all floor tubes must be covered during construction with a light board.

Wires.—For mains a conductor having an insulation known as "fire and weatherproof" and for branches the standard twin conductor of the Interior Conduit and Insulation Co. must be used.

Annunciator Wiring.—All annunciator or bell wires must be placed within conduits and such of the foregoing rules and regulations as are applicable to rendering them accessible and affording suitable protection shall be followed.

Inserting Wires.—After the conduiting is completed powdered soapstone must be blown into the tubes in order to facilitate the drawing in of the wires.

Inspection and Acceptance.—As a guarantee that the wiring will be properly done, it is required that the contractors, in event of their being unfamiliar with the system, communicate with the Interior Conduit and Insulation Co., of New York, or their authorized representatives, and obtain the requisite instruction. The right is reserved to subject the work of the contractor to the inspection and approval of the Interior Conduit and Insulation Co. as a condition of acceptance and final payment.

ON THE ALTERNATING ELECTRIC ARC BETWEEN A BALL AND POINT.[1]

BY EDWARD L. NICHOLS.

THE phenomenon which forms the subject of this paper, was first brought to my notice by Mr. E. G. Acheson, the result of whose unpublished observation, may be briefly stated as follows:

Two wires, which formed the terminals of the secondary coil of an alternating current transformer, were brought nearly into contact. One wire was armed with a ball, the other with a point. When the distance was such as to admit of a discharge between the two, it was found that a galvanometer in shunt around the ball and point, indicated a considerable flow of continuous current.

This phenomenon has recently been subjected to investigation by Messrs. Archbold and Teeple. Their experiments, from which in great measure, the data used in the first part of this paper have been taken, are described at length in their Thesis in Electrical Engineering, which is now in the library of Cornell University.[2]

The apparatus used in the verification of Mr. Acheson's observation, consisted of a Ruhmkorff coil of moderate size, the interrupter and condenser of which had been thrown out of circuit. The primary coil, as in all instruments of that type, consisted of a few turns of heavy wire, surrounding a core of iron wires. When this coil was supplied with current from a small alternating dynamo, making 14,000 reversals a minute, and the terminals of the secondary coil were brought into position, a discharge of considerable brilliancy took place between them. To the unaided eye, the discharge appeared to be perfectly continuous, but the fact that it was really of an intermittent and periodic character, was indicated by the emission of a well defined musical note, which corresponded in frequency with the period of alternation of the dynamo.

The following quotation will serve to indicate the conclusions reached by the observers in the course of their preliminary experiments with the platinum point:

"The behavior of the arc, as its length is increased, is very curious. As the point is withdrawn the arc forms and sings with an even tone, the pitch corresponding to the number of alternations. The point becomes of a dull red color while the galvanometer gives a small but quite steady deflection. As the arc is drawn out, it sings louder and more harshly, the point becomes redder, while the galvanometer deflection increases and becomes very unsteady. At a certain critical length the following phenomena suddenly occur; the tone becomes smooth and even, the point brightens almost to a white heat, the intensity depending upon the strength of the current, while the galvanometer deflection becomes much greater and very steady. The explanation suggested, and which subsequent experiments seem to confirm, is as follows: At first the arc forms both ways, the rapid succession giving the tone. As the arc lengthens the arc still forms from ball to point, but is only intermittent (occasional) from point to ball, giving the unsteady tone and deflection. Finally the distance becomes too great for the arc to form from the point to the ball while it still passes freely the other way, and the tone and deflection become steady."

It was to the conditions existing in the circuit when the critical length of the arc, above mentioned, had been reached, that Messrs. Archbold and Teeple chiefly devoted themselves.

The main portion of the investigation consisted in the determination of the periodic changes of electromotive force and current during a complete cycle, when no arc existed, and of the modifications introduced into the curves of potential and current by the discharge between ball and point. Throughout the entire series of measurements, the striking distance was greater than the critical value already defined, a condition the maintenance of which was secured by watching the indications of the galvanometer.

The ball and point phenomenon is unquestionably very closely related to a class of effects with which students of static electricity have long been acquainted.

In view of the experiments described in the present paper, it appears that what is true in this particular of the spark from the Leyden jar and the discharge of the Holtz machine, is true also of the alternating current arc.

After the completion of the experiments of Messrs. Archbold and Teeple, the study of the ball and point phenomenon was taken up under the writer's direction by Mr. F. C. Caldwell; the chief purpose of the investigation being to test the applicability of the effect to alternate current measurement.[3]

Irregularities of action due to rapid changes in the surfaces of the point and ball, by corrosion and disintegration under the arc, finally caused the attempt to be abandoned for the time being, but Mr. Caldwell in the course of his work made a large number of observations of the discharge under various conditions. Many of these are of interest in this connection on account of the light which they throw upon the original experiments, and because of the lines of further research which they suggest.

From these observations it appears:

1. That the discharge from the ball (positive) leaves the latter in a direction normal to the surface, but that it enters the other terminal at some distance from the apex.

2. That the discharge from the point (positive) leaves the very apex of the latter, but is deflected into a course nearly 45° from the axis and reaches the ball obliquely at some point on its side.

Taking these observations into consideration, the explanation of the cessation of the discharge from the point at the critical distance and of the establishment of the "one way" arc, follows at once. The two paths of discharge differ in length and for a given electromotive force, the maximum striking distance is sooner reached in the case of the oblique than of the normal arc, so that the latter continues to pass at greater distances (of ball and point) than the former.

Definite results were obtained only while the platinum surface was new and bright.

In this brief account of Mr. Caldwell's experiments, I have omitted to mention many of the observations recorded by him. He had occasion in the course of his investigation, to study the discharge under a variety of conditions, and found that when liquid surfaces (mercury or water) were used in place of the ball; also that when hydrogen, carbon-dioxide or illuminating gas were substituted for air, as a dielectric, the ball and point effect, more or less modified, could still be obtained. The investigation of these points, although it has already led to some results of significance, is as yet very incomplete.

PHYSICAL LABORATORY OF CORNELL UNIVERSITY: Sept., 1890.

THE DIFFERENCE OF POTENTIAL BETWEEN TWO DILUTE SOLUTIONS OF BINARY ELECTROLYTES.

THE development of electricity and heat in electrolytes has been the subject of much investigation during the past few months by M. Planek, who has contributed several papers to Gilbert's *Annalen der Physik und Chemie*. In one of these papers (*vide* Series [2], Vol. xxxix., p. 161) he argued that since the ions of an electrolyte are endowed with large electrostatic charges, it follows that before the electromotive forces become active a certain finite determinable amount of free electricity must be formed in the solution. The forces necessary to cause a movement of electricity in an electrolyte are referred to in this paper, starting with the assumption that in an electrolyte the ions are present in a fully dissociated condition.

Planek now considers (*vide Annalen Phys. Chem.*, Series [2], Vol. xl., p. 561) the integration of the differential equations for the general case of two solutions containing different electrolytes, having already calculated the difference of potential for the case of two solutions containing the same electrolyte in different proportions.

The existence between the two solutions of a limiting layer of small but still finite thickness is assumed. Different values for the difference of potential are found according to the way in which the concentration is supposed to alter within the intermediate layer. Planek shows, however, that in a very short time a state of stability will be reached in which the total concentration (sum of the concentrations of the positive or negative ions) will vary within the layer as a linear function of the distance. This consideration is sufficient to make the above problem uniquely soluble, supposing the electrolytes to be completely dissociated. Planek compares the calculated values for the difference of potential with Nernot's experimental numbers, with which they show a satisfactory agreement.

ELECTRIC LIGHT STATIONS RUNNING ELECTRIC ROADS.

There is a tendency in many towns either to consolidate the electric light and electric railway interests or furnish power to the road from the electric light station. Among the companies adopting the latter practice is the Zanesville Electric Light Co., which has made a contract for ten years with the Zanesville Street Railway Co. for furnishing motive power for its electric road.

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[1] Abstract from the *American Journal of Science*, Jan. 18, 1891.

[2] The Effect of Placing a Ball and Point in a High Potential Alternating Current Circuit, by W. K. Archbold and G. L. Teeple. Thesis in MS., Cornell University Library: 1889.

[3] Frank Cary Caldwell: A study of the Alternating Arc between a Ball and Point. Thesis in MS. Library of Cornell University, 1890.

ELECTRICITY IN TRANSITU: FROM PLENUM TO VACUUM.

BY WM. CROOKES, F. R. S.

(*Continued.*)

EXPLORATION WITH IDLE POLES.

Wishing to learn something of the electrical condition of the matter within and without the dark space, I made a tube, Fig. 7, having, besides the positive and negative terminals, A B, two extra intermediate poles, C and D; the tube showed that when the exhaustion was such that both the idle poles were outside the dark space, on passing the current through the tube, there was a considerable difference of potential between them when measured on the galvanometer. If the exhaustion was carried so high that one of the extra poles was just on the border of the dark space, then no current passed between them. When the exhaustion was still further increased so as to enclose one of the extra poles fully in the dark space, again there was a great difference of potential between them, but the direction was reversed, the pole at highest potential now being the one formerly at lowest potential.

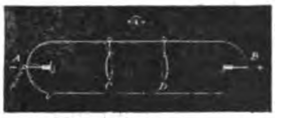

FIG. 7.—P = 75 mm.

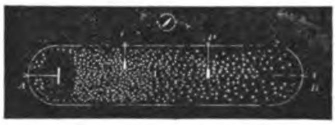

FIG. 8A.—P = 0.25 mm. = 330.0 M.

When the dark space has been further explored by means of a movable negative pole, I found that the effects did not depend essentially on the exhaustion, and were really due to the position occupied by the extra poles with regard to the dark space.

These phenomena are difficult to understand from mere description, and the experiments themselves are not easy to carry out so as to be visible to many at a time. I have here, however, a working model of an apparatus which will make these puzzling indications clear to all.

A cylindrical tube, Fig. 8, *a*, *b* and *c* (P.=0.25 mm.), furnished with the usual poles, A B, at the ends, has two extra or idle poles near together at C and D. The pole A is movable along the axis of the tube, so that when exhausted the dark space can be brought to any desired position with respect to the idle poles C and D. The shading and + and — marks roughly show the distribution of positive and negative electricity inside the tube. I start with the negative pole, A, as far as possible from either idle pole, Fig. 8*a*. Turning on the coil you see the dark space surrounding the pole A, and the idle poles quite outside.

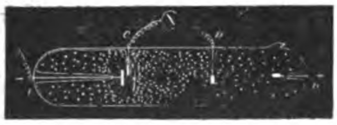

FIG. 8B.—P = 0.25 mm. = 330.0 M.

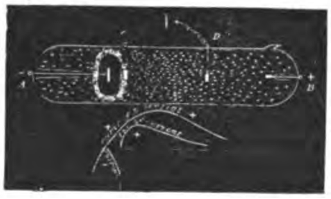

FIG. 8 C.—P = 0.25 mm. = 330.0 M.

The shading shows that each idle pole is in the positive area, and on testing with a gold leaf electroscope it will be seen that each is charged with positive electricity. But the shading also shows more positive at C than at D and on connecting C and D with a galvanometer the needle indicates a rush of current from C to D, D being negative to C.

The dark space is next brought to such a position that the pole C is well within it, Fig. 8*b*. A change has now come over the indications. The galvanometer shows a reverse current to that which was seen on the former occasion. C is now negative and D positive, but the gold leaves still tell us both poles are positively electrified.

At a certain position of the dark space, when its edge is on the pole C, Fig. 8*c*, a neutral state is found at which the gold leaves still show strongly positive electrifications, and no current is seen on the galvanometer. The curves below, Fig. 8*c*, roughly show the rise and fall of negative and positive current at different parts of the tube, whilst the potential curve keeps positive.

When a substance that will phosphoresce under electrical excitement is introduced into the tube, the position of greatest luminosity is found to be at the border of the dark space, just where the two opposing armies of negative and positive atoms meet in battle array and recombine. Later on I shall refer to this phenomenon in connection with the phosphorescence of yttria.

RADIANT MATTER.

By means of this tube, Fig. 9, I am able to show that a stream of ultra-gaseous particles, or radiant matter, does not carry a current of electricity, but consists of a succession of negatively electrified molecules whose electrostatic repulsion overbalances their electromagnetic attraction, probably because their speed along the tube is less than the velocity of light. The tube has two negative terminals, A A′, close together at one end, enabling me to send along the tube two parallel streams of radiant matter, rendered visible by impinging them through holes in a mica diaphragm on a screen of phosphorescent substance. It is exhausted to a pressure of 0.1 mm. I connect one of the negative poles, A, with the induction coil and the luminous stream darts along the tube from C to D parallel with the axis. I now connect the other negative pole, giving a second parallel stream of radiant matter. If these streams are in the nature of wires carrying a current they will attract each other, but if they are simply two streams of electrified molecules they will repel each other. As soon as the second stream is started you see the first stream jump away in the direction C E, showing strong repulsion, proving that they do not act like current carriers, but merely like similarly electrified bodies. It is, however, probable that were the velocity of the streams of molecules greater than that of light, they would behave differently and attract each other, like conductors carrying a current.

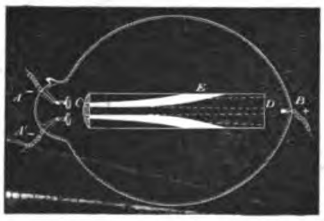

FIG. 9.—P = 0.1 mm. = 131.5 M.

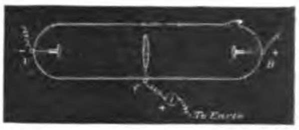

FIG. 10.—P = 0.0001 mm. = 0.13 M.

To ascertain the electrical state of the residual molecules in a highly-exhausted tube such as you have just seen, I introduced an idle pole or exploring electrode between the positive and negative electrodes in such a manner that the molecular stream might play upon it. The intention was to ascertain whether the molecules on collision with an obstacle gave off any of their electrical charge. In this experiment, Fig. 10 (P. = 0.0001 mm., or 0.13 M[1]), it was found that an idle pole, C, placed in the direct line between the positive and the negative poles, A B, receiving in consequence the full impact of the molecules shot from the negative pole, manifested a strong *positive* charge.

THE EDISON EFFECT.

An exactly parallel experiment has been made by Mr. Edison, Mr. Preece, F. R. S., and Professor Fleming, using, instead of a vacuum tube, an incandescent lamp. They found that from an idle pole placed between the ends of the filament the electricity always flowed as if the pole were the zinc element of a copper-zinc cell; having repeated their experiments I entirely corroborate them. I get a powerful current in one direction from an idle pole placed between the limbs of an incandescent carbon filament and one in the opposite direction from an idle pole in a highly-exhausted vacuum tube. This discrepancy was extremely puzzling, and I tested, with a similar result, very many experimental tubes made in different ways. The electricity obtained from an idle pole placed between the positive and negative terminals in a highly-exhausted tube was always strongly *positive*, and it is only recently that continued experiment has cleared the matter up.

Some of the contradictory results are due to the exhaustion not being identical in all cases. In my vacuum tubes the directions of current between the idle pole and the earth changes from negative to positive as the exhaustion rises higher. Testing the current when exhaustion is proceeding, there is a point reached when the galvanometer deflection—hitherto negative—becomes nil, showing that the potential at this point is zero. At this stage, the passage of a few more drops of mercury down the pump tube renders the current positive. This change occurs at a pressure of about 2 mm.

AFTER this point is reached, when the induction current is passed through the tube, the walls rapidly become positively electrified, probably by the friction of the molecular stream against the glass, and this electrification extends over the surface of any object placed inside the tube. I will show you how this electrification of the inner walls of the tube acts on the molecular stream at high vacua. In this tube, Fig. 11 (P. = 0.001 mm. or 1.3 M.) are fixed to exactly similar phosphorescent screens, C and D; at one end of each is a mica gate, E E', with a negative pole, A A', facing it. One of the screens, C, is in the cylindrical part of the tube and close to the walls; the other, D, is in the spherical portion, and therefore far removed from the walls. On passing the current the screen D in the globe shows a narrow sharp streak of phosphorescence, proving that here the molecules are free to follow their normal course straight from the negative pole. In the cylindrical part of the tube, however, so great is the attraction of the walls that the molecular stream is widened out sufficiently to make the whole surface of the screen C glow with phosphorescent light.

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[1] M. = one-millionth of an atmosphere. 1,000,000 M. = 760 mm. 1,000,000 M. = one atmosphere.

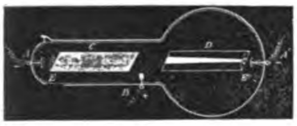


FIG. 11.—P = 0.001 mm. = 1.3 M.

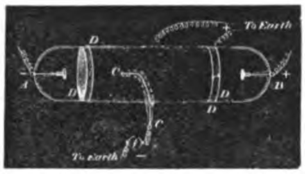


FIG. 12.—P = 0.0001 mm. = 0.13 M.

If an idle pole, C C, Fig. 12 (P. = 0.0001 mm. or 0.13 M.), protected all but the point by a thick coating of glass, is brought into the centre of the molecular stream in front of the negative pole, A, and the whole of the inside and outside of the tube walls are coated with metal, D D, and "earthed," so as to carry away the positive electricity as rapidly as possible, then it is seen that the molecules leaving the negative pole and striking upon the idle pole C on their journey along the tube carry a negative charge, and communicate negative electricity to the idle pole.

This tube is of interest since it is the one in which I was first able to perceive how in my earlier results I always obtained a positive charge from an idle pole placed in the direct stream from the negative pole. Having got so far, it was easy to devise a form of apparatus that completely verified the theory, and at the same time threw considerably more light upon the subject. Fig. 13, *a*, *b*, *c*, is such a tube, and in this model I have endeavored to show the electrical state of it at a high vacuum by marking a number of + and — signs. The exhaustion has been carried to 0.0001 mm., or 0.13 M., and you see that in the neighborhood of the positive pole, and extending almost to the negative, the tube is strongly electrified with positive electricity, the negative atoms shooting out from the negative pole in a rapidly-diminishing cone. If an idle pole is placed in the position shown at Fig. 13, *a*, the impact of positive and negative molecules are about equal, and no decided current will pass from it, through the galvanomer, to earth. This is the *neutral* point. But if we imagine the idle pole to be as at Fig. 13, *b*, then the positively electrified molecules greatly preponderate over the negative molecules, and positive electricity is shown. If the idle pole is now shifted as shown at Fig. 13, *c*, the negative molecules preponderate, and the pole will give negative electricity.

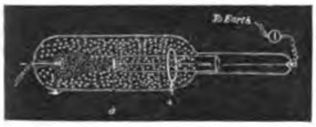


FIG. 13 A.—P = 0.0001 mm. = 0.13 M.

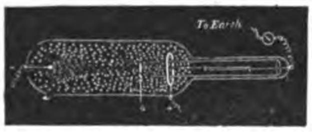


FIG. 13 B.—P = 0.0001 mm. = 0.13 M.

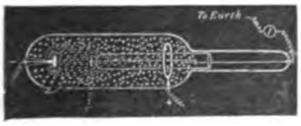


FIG. 13 C.—P = 0.0001 mm. = 0.13 M.

As the exhaustion proceeds, the positive charge in the tube increases, and the neutral point approaches closer to the negative pole, and at a point just short of non-conduction so greatly does the positive electrification preponderate that it is almost impossible to get negative electricity from the idle pole, unless it actually touches the negative pole.

PROPERTIES OF RADIANT MATTER.

One of the most characteristic attributes of radiant matter—whence its name—is that it moves in approximately straight lines, and in a direction almost normal to the surface of the electrode. If we keep the induction current passing continuously through a vacuum tube in the same direction, we can imagine two ways in which the action proceeds; either the supply of gaseous molecules at the surface of the negative pole must run short, and the phenomena come to an end, or the molecules must find some means of getting back. I will show you an experiment which reveals the molecules in the very act of returning. Here is a tube (Fig. 14) exhausted to a pressure of 0.001 mm. or 1.3 M. In the middle of the tube is a thin glass diaphragm, C, pierced with two holes, D and E. At one part of the tube a concave pole, A', is focussed on the upper hole, D, in the diaphragm. Behind the upper hole and in front of the lower one are movable vanes, F and G, capable of rotation by the slightest current of gas through the holes.

On passing the current with the concave pole negative, the small vanes rotate in such a manner as to prove that at this high exhaustion a stream of molecules issues from the lower hole in the diaphragm, whilst at the same time a stream of freshly charged molecules is forced by the negative pole through the upper hole. The experiment speaks for itself, showing as forcibly as an experiment can show that so far the theory is right.

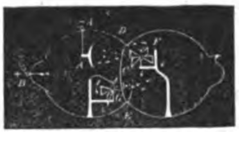


FIG. 14.—P = 0.001 mm. = 1.3 M.

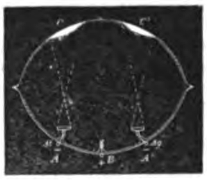


FIG. 15.—P = 0.00068 mm. = 0.9 M.

RADIANT MATTER AND "RADIANT ELECTRODE MATTER."

Some metals it is well known, such as silver, gold or platinum, when used for the negative electrode in a vacuum tube, volatilize more or less rapidly, coating any object in their neighborhood with a very even film. On this depends the well-known method of electrically preparing small mirrors, etc. Aluminum, however, seems exempt from this volatility. Hence, and for other reasons, it is generally used for electrodes.

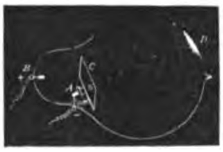


FIG. 16.—P = 0.00088 mm. = 0.9 M.

If, then, the phenomena in a high vacuum are due to the "electrode matter," the more volatile the metal used the greater shall be the effect.

Here is a tube (Fig. 15, P = 0.00068 mm., or 0.9 M.) with two negative electrodes, A, A', so placed as to project two luminous spots on the phosphorescent glass of the tube. One electrode, A', is of pure silver, a volatile metal, the other, A, is of aluminum, practically non-volatile. A quantity of "electrode matter" will be shot off from the silver pole and practically none from the aluminum pole; but you see that in each case the phosphorescence, C, C', is identical. Had the radiant electrode matter been the active agent the more intense phosphorescence would proceed from the more volatile pole.

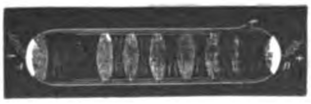


FIG. 17.—P = 2.0 mm.

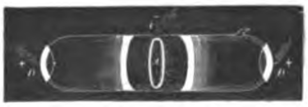


FIG. 18.—P = 0.076 mm. = 100.0 M.

A drawing of another experimental piece of apparatus is shown in Fig. 16. A pear-shaped bulb of German glass has near the small end an inner concave negative pole, A, of pure silver so mounted that its inverted image is thrown upon the opposite end of the tube. In front of this pole is a screen of mica, C, having a small hole in the centre so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot, D, at the far end of the bulb. The exhaustion is about the same as in the previous tube, and the current has been allowed to pass continuously for many hours so as to drive off a certain portion of the silver electrode, and upon examination it is found that the silver has all been deposited in the immediate neighborhood of the pole, whilst the spot, D, at the far end of the tube that has been continuously glowing with phosphorescent light, is practically free from silver.

The identity of action of silver and aluminum in the first case, and the non-projection of silver in this second instance, prove that phosphorescence is independent of the material of the negative electrode. In front of me is a set of tubes that to my mind puts the matter wholly beyond doubt. The tubes contain no inside electrodes with the residual gaseous molecules, and with them I will proceed to give some of the most striking radiant matter experiments without any inner metallic poles at all.

In all these tubes the electrodes, which are of silver, are on the outside, the current acting through the body of the glass. The first tube contains gas only slightly rarefied and at the stratification stage. It is simply a closed glass cylinder, with a coat of silver deposited outside at each end, and exhausted to a pressure of 2 mm. The outline of the tube is shown in Fig. 17. I pass a current and, as you see, the stratifications, though faint, are perfectly formed.

The next tube, seen in outline in Fig. 18, shows the dark space. Like the first, it is a closed cylinder of glass, with a central indentation, forming a kind of hanging pocket, and almost dividing the tube into two compartments. This pocket, silvered on the air side, forms a hollow glass diaphragm that can be connected electrically from the outside, forming the negative pole, A; the two ends of the tube, also outwardly silvered, form the positive poles, B, B. I pass the current and you all see the dark space distinctly visible. The pressure here is 0.076 mm., or 100 M.

(*To be Continued.*)

European Correspondence.

LONDON.

Durham Cathedral.—Lighting of the City of London.—New Continental Companies.

It is intended to light the fine old Cathedral Church of Durham by electricity; power will be obtained from the neighboring river Wear.

I mentioned in a previous communication that the Commissioners of Sewers for the City of London had given out contracts for the lighting of the streets to the Brush Company and Messrs. Laing, Wharton & Down, the representatives of the Thomson-Houston system. Of course the city area only extends from Oldgate to Temple Bar, but it is a district which will repay the enterprise. The terms of the undertaking have been made public and are full of interest to electricians.

The provisional orders confirming the contracts differ in many points from other orders. The terms of purchase are considerably modified from the act of 1888, and the sliding scale of the gas acts is adopted, by which consumers are benefited by a reduction in price in proportion to dividends over and above 10 per cent. For instance, the maximum charge per Board of Trade unit is 8d. Suppose the company elect in the beginning to charge at this rate, and suppose they thus earn 11 per cent; for the additional 1 per cent. they are compelled to reduce the charge of 8d. a unit by a half penny and so on.

The Brush Company has already secured a most eligible site of 40,000 feet on the Surrey side, and Laing, Wharton & Down have, I hear, also secured a river side site. As cheapness of fuel is a great consideration, the companies are most fortunately situated.

Eventually the concessions will be transferred to a limited liability company, or it may be two, which will be floated at a favorable turn of the money market. Work, however, is to be commenced immediately, and the two contractors will soon be in the position, as their custom, is of vending a going concern, retaining a proportion of the shares and the engineering control. Of these financial details nothing is yet known, nor in fact is anything settled. They are in the same hands, both in the interests of the Brush Company and of Laing, Wharton & Down, and are understood to rely on powerful and influential support.

The concessions do not interfere with the private lighting, of which there is a good deal in the city, but it is reasonable to expect that consumers will abandon private plants and use current from a central station.

The local authorities have the right to acquire the undertaking, so far as it relates to public lighting, at the end of 21 years upon the terms fixed by the Electric Lighting Act, and they have the right to acquire the undertaking, so far as it relates to private lighting, at the end of that period on paying its value as a going concern. They have the right to buy up at the end of 42 years, or at the end of any subsequent 10 years, upon the terms of the Act, but until the undertaking is so purchased, the concession as to private lighting is not determinable except in the event of certain defaults by the contractors. The contract as to public lighting is determinable by either party at the end of seven, fourteen or twenty-one years. The commissioners have agreed not to consent to any other company obtaining a provisional order during the first twenty-one years. The work of laying the mains has to be commenced before February 19, and completed about two years hence. They have to be laid underground, overhead wires being absolutely prohibited. The preliminary work of equipping the central generating stations is already in progress, and it is expected that the first thoroughfare to be illuminated—Queen Victoria street—will be speedily out of hand. Here, however, there already exists the great convenience of a subway.

The present public lighting bill of the city is rather less than £10,000 a year. The future cost will be rather more than £20,000. Roughly speaking gas lamps of which the probable candle-power is 40,000 are to be replaced by electric lamps of 800,000 candle-power. There are now in each of the three divisions about 1,000 gas lamps. They will be replaced by a gross total of about 400 arc lamps and 1,000 glow lamps. For main thoroughfares arc lamps costing for maintenance £26 each a year will be used, and in smaller streets, lanes and courts glow lamps costing each for maintenance £5 or £10 a year. The arc lamps have each a nominal candle-power of 2,000 candles and they will be placed at intervals of about 250 feet. For private lighting both companies will use the alternating current system, but the pressure will not exceed that of which electrical engineers have had successful experience.

The Anglo-Austrian Bank of Vienna and the firm of Siemens and Halske, of Berlin, have just formed three new electrical companies with headquarters in the former city. The first is the Austrian General Electricity Company, constituted, with a capital of £312,000, for the purpose of constructing and working central electric light stations. The second is the Electric Tramway Company, with a capital of £312,000 for the building and working of electric tramways; and the company have already acquired the Buda-Pesth electric tramway. The third is the International Compressed Air and Electricity Company, with the same amount of capital, and formed to work a concession obtained from the Vienna municipality for lighting the city by electricity.

H. S.

London, Jan. 7, 1891.

LONDON.

City Electric Railway.—Mutual Telephone Co.—Swedish Telephones.—Brighton Company and its Customers.—Meetings of Companies.

The City and South London Railway authorities are going to apply for power authorizing an extension of the existing system to Islington in the North, a distance of two miles. There cannot be a better mark of its general success than the fact that the average number of passengers who use the underground electric line in one day is 25,000. The chief problem to be dealt with by the traffic manager is the enormous crowds of people who wish to travel, and soon the intention to run trains every three minutes instead of five must take effect.

It is announced that the Mutual Telephone Company, Limited, will open for traffic early next month the first section of their Manchester Telephone Exchange, and that they hope to commence work in Liverpool very soon afterwards. Orders for between 1,600 and 1,700 wires have been already obtained in Manchester, and as a considerable number of orders have also been booked in Liverpool the new undertaking may be said to make a hopeful beginning. The rentals will, it is understood, show a considerable reduction upon those at present charged, but the object in view is not so much to reduce rentals as to provide a really good telephonic service, which is certainly badly wanted. This company has secured as manager Mr. A. R. Bennett, late of the National Telephone Company.

The State Telegraph Dept. of the Swedish Govt. has purchased another private telephone concern; this time it is the large Haglind telephone installation which embraces forty central stations in the provinces of Ostergötland, Smaland and Nerika, and has about five hundred subscribers.

The Senate house in Madrid is being fitted with the fixtures for electric lighting.

A novel, and at the same time drastic method has been adopted by the Brighton Electric Light Company in dealing with the opposition which they have encountered from the local authority. Without the permission of this body the company cannot obtain a provisional order, although they have for some time supplied current. They informed their clients that unless they signed an agreement to take current for three years the supply would be cut off. About two-thirds of the total number of customers have agreed to this.

At a meeting of the shareholders of Woodhouse & Rawson, United Limited, held on Friday, resolutions were passed increasing the capital and authorizing the directors to arrange the repayment to the preceding company's liquidations of the amount deposited by them as a dividend guarantee fund.

On the same day was held in London, the first meeting of the French Elmore Copper Company, when M. Secretan was present. It was a mere exchange of compliments between the Board and the shareholders.

H. S.

London, Jan. 14, 1891.

Home Correspondence.

BOSTON.

A Board of Gas and Electric Control.—Fire-Alarm Telegraphs.—Elevated Roads.—The Huntington Search Light.

In the Senate this week an order was adopted by Mr. Champlin, of Suffolk, as to abolishing the board of gas and electric light commissioners, and appointing a board of gas and electric light control, to consist of one gas engineer, one electric light engineer, and one lawyer.

At a meeting of the Board of Aldermen the committee on fire department reported an order which was passed for the repeal of so much of an ordinance as gives the inspectors of wires the control of the fire-alarm telegraph system. The fire commissioners claim that the taking of the system from their control was contrary to their views and was detrimental to the best interest of the fire department. The two departments are so closely allied that they cannot be separated, and the efficiency of the fire department is dependent upon the reliability of the fire-alarm telegraph department. Any failure of the latter department would tend to cripple the former and the fire commissioners would be held responsible.

There was a hearing this week before the street railway committee on the petition of the Old South Society and others that the West End Street Railway Company shall not be permitted to build elevated structures, until a commission appointed to examine and determine the best system of elevated railways for the city of Boston shall report upon the expediency of their plan. General opinion appears to be in favor of such a commission, and that there should be an exhaustive inquiry into the modes of rapid transit before allowing an elevated structure to be built. Mr. H. M. Whitney, president of the West End Company, did not oppose the appointment of a committee but accepted it as a necessity, though he believed that its conclusion would be the same already arrived at by the officers of the company.

Some experiments were made this week from the roof of the Edison Illuminating Company, of Boston, on a new 8,500 candle power Huntington search light, which is attracting considerable attention amongst railroad men and those interested in steam navigation.

Boston, Feb. 7, 1891.

Letters to the Editor.

CHEAP LIGHTING IN BUFFALO.

Enclosed please find an advertisement of the Citizens' Gas Co., lowering gas to 75 cents per 1,000 feet. Large consumers have used gas at $1 per 1,000 for several years. I do not think that any municipality in the lighting business furnishes light for less rates. A.

Notice to Gas Consumers.

The Citizens' Gas Co. announces that in those streets in which the mains of said company and of the Municipal Gas Light Co. are both laid, the Citizens' Gas Co. has reduced the price of gas to 75 cents per 1,000 from Feb. 1, 1891.

M. F. Reynolds, President.

Buffalo, Jan. 24, 1891.

ELECTRIC LIGHTING AT SAN DIEGO, CAL.

While enumerating some of the principal institutions of San Diego, Cal., *The San Diego Union* has this to say about the electric light system of the city: "The incandescent system of electric lighting was introduced about two years ago by the Electric Rapid Transit Street Car Company, George D. Copeland, president, and has become an assured success under his management, reducing the rates of commercial and domestic lighting beyond any which ever before prevailed in this city. In fact, the rates for gas and electric lights are now lower in San Diego than those prevailing in other towns on the Pacific coast, where steam power is used, and should the project to use the water-power at the end of the flume materialize, still further reduction in rates may be expected.

"The present Copeland plant consists of two Westinghouse alternating current incandescent dynamos of a capacity of 750 16 candle power lamps each, including exciters, switch-boards and electrical instruments. The dynamos are run by steam power, and so complete are all the operations of the system that there has been no interruption in the regular business of light distribution during the past year."

Society and Club Notes.

SPECIAL TRAIN FOR THE N. E. L. A. MEETING AT PROVIDENCE, R. I.

The Committee on Transportation announce that to accommodate delegates going from and through New York to the ensuing meeting of this Association, at Providence, R. I., they have arranged for a train of parlor buffet cars to leave the Grand Central depot on Monday, February 16, at 1 P. M., arriving in Providence at 6:15 P. M.

Applications for seats must be made to Gen. C. H. Barney, previous to 6 P. M. on Friday, 13th inst., accompanied by a remittance of $1.00 for each seat desired. This is imperative, as the necessary cars will be ordered in on Saturday. Seats will be allotted in the order in which applications are received.

Delegates from points west and south of New York, desiring to take this train, should purchase their through tickets, via "Shore Line Route" from New York.

For the convenience of New York delegates desiring tickets on the certificate plan, and to avoid a rush at the station, a representative of the railroad company will be at the Electric Club, 17 East 22nd street, New York City, on Saturday, 14th inst., at 8 P. M. to deliver tickets and issue certificates.

Single (train) fare from New York to Providence.....	$4.30
Return fare if certificate is obtained...........	1.34
Making the round trip.	$5.64

Extra charge for seats in parlor car, $1.00.

Secretary Foote has issued a very neat and tasteful little pamphlet of 64 pages, giving details as to the Convention, the place of meeting, the invitations from local concerns, etc.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of Feb. 7, 1891, from New York, Boston and Washington; Pittsburgh, Feb. 6.

NEW YORK.

	BID.		BID.
W. U. Tel. Co..............	81¾	Edison Gen. Elec. Co.....	101⅛
American Tele. & Cable...	83	Consol'd Elec. Lt. Co......	...
Centl. & So. Amer.........	145	Edison Illn'g Co. N. Y.... .	79
Mexican.....	210	U. S. Elec. Lt. Co...	30
Com. Cable Co......... ...	104	North Am. Phonograph ...	15
Postal Tel. Cable..........	39		

BOSTON.

	BID.		BID.
Thomson-Houston.........	*46½	Ft. Wayne Co.............	13⅝
" Pref'd....	25½	Am. Bell...................	194
" Series C.....	13¼	" Rights..........	18
" " D....	7⅛	Erie...................... ..	*47½
" Int. Co.....	....	New England.............	*50
Thomson Welding Co.. ...	....	Mexican.................	.65 cts
Thomson Eu. Welding.....	60	Trop. American..........	..
		Edison Phon'gph Doll....	1

WASHINGTON.

	BID.		BIT.
Penna. Telephone.........	25	U. S. Elec. Lt (Wash).....	135
Ches. & Pot. Telephone....	63	Eck.&Sold. Home Elec. Ry.	56¼
Amer. Graphophone.......	8¼	Georgetown & Tenallytown	51

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co.......	16¼

* Ex Dividend.

A DINNER TO PROF. THOMSON.

The departmental foremen, electricians and assistants of the Thomson-Houston company gave a dinner recently to Prof. Thomson at the Parker house, Boston. Professor Thomson gave an interesting account of his early struggles in inventing and perfecting electrical apparatus, and Mr. E. W. Rice, Jr., superintendent of the works, made interesting remarks.

Reports of Companies.

BUFFALO STREET RAILWAY CONSOLIDATION, &C.

The stockholders of the Buffalo Railway Company have effected a complete consolidation of all street railroad interests in that city. Certificates of the surrender of the capital stock of the Buffalo East Side Street Railway Company and the Buffalo Street Railroad Company to the Buffalo Railway Company have been filed in the Secretary of State's office. The Buffalo Railway Supply Company has also filed a certificate of an increase of its capital from $100,000 to $200,000.

THE SEATTLE ELECTRIC RAILWAY LINES SOLD.

An arrangement has been made by which a large portion of the stock of the Seattle Electric Railway and Power Company is transferred to Eastern capitalists. Articles of incorporation have been filed by a new corporation to which the property of the old company was transferred, and which has a capital stock of $1,500,000, divided into 1,500 shares of $1,000 each. This new company takes the name of the Seattle Consolidated Street Railway Company, and the incorporators are F. T. Blunck, of Davenport, Iowa; D. T. Denny, George Kinnear, G. K. Carter, J. E. Porter, Rebecca M. Kinnear, J. F. Hale, V. Hugo Smith, L. H. Griffith, E. C. Kilbourne, J. Furth, A. Dunne, George E. Miller, L. D. Ross, F. M. Griffith.

At a meeting held recently the company was temporarily organized by the election of the following trustees, who will manage its affairs until the second Monday in April: D. T. Denny, J. F. Hale, E. C. Kilbourne, L. H. Griffith, George Kinnear, V. Hugo Smith and J. E. Porter. The majority of the stock still remains in the hands of the Seattle stockholders, so that they will retain control of the property.

THE MERRIMAC VALLEY STREET RAILWAY SOLD.

The change in ownership in the Merrimac Valley Street Railway, at Lawrence, has come to pass, and the road goes into the hands of New York capitalists. Of the 800 shares of stock 760 have been sold at $250 per share. As the old company bought the stock last summer at $150 per share, it makes a handsome profit.

The new owners are William A. Perrin and J. N. Beckley, both of Rochester, N. Y. Albert D. Bosson, of Chelsea and Nathan E. Morton of Lawrence retire from the board of directors, and the New Yorkers take their places. President Ferguson, of Salem, will retain his position, while Albert E. Butler, of Boston, will remain as treasurer. E. P. Shaw, of Newburyport, remains on the board of directors.

The Railroad Commissioners will be asked shortly to authorize the increasing of the capital stock of the road from $80,000 to $300,000. Then electricity will be put in and a line will be built to Andover. All the improvements contemplated by the old company will be carried out by the new owners.

ANNUAL MEETING OF THE CROCKER-WHEELER ELECTRIC MOTOR CO.

At the annual meeting of this company held at their office 430 West 14th street, on Jan. 7, 1891, the following officers and directors were elected for the ensuing year: S. S. Wheeler, president; F. B. Crocker, vice-president; H. H. Crocker, treasurer; and R. N. Peterson, A. F. Higgins, Wm. B. Baldwin, A. K. Sloan, David Crocker, directors. The annual sworn statement showed a full paid capital of one hundred thousand dollars, while the total indebtedness was less than nine thousand dollars, and consisted only of the ordinary open monthly accounts. The statement showed that the business of the company had about doubled in each quarter year.

EAST END ELECTRIC LIGHT CO., PITTSBURGH.

The annual report of the East End Electric Light Company shows gross earnings for the twelve months ending December 31st, 1890, $88,344, and operating expenses of every kind, $46,710, leaving net earnings of $40,733. After the payment of $11,133 interest on bonds and interest and discounts, there remained a surplus of $29,600 or about 5½ per cent. on the capital. The assets foot up $803,887, as follows: Cash on hand, $1,945; accounts receivable, all goods, $41,528; house wiring material on hand, $8,229; horses and vehicles, $1,335; office furniture, $1,761; artesian well and appurtenances, $7,094; interest on bonds accrued but not due, and insurance paid but not charged to expense as yet, $1,092; real estate, $14.423; buildings, $31,126; construction and equipments, $695,319. The liabilities are as follows: Capital stock, full paid, $500,000; first mortgage 6 per cent. coupon bonds due April 1st, 1909, interest payable April and October, $150,000; accounts and bills payable, $108,711; total, $758,711; balance to credit of profit and loss, being net earnings to December 31st, 1890, $45,175.

The floating debt of the company is provided for by an authorized issue of $100,000 second mortgage 6 per cent. coupon bonds, due Jan. 1st, 1911; a portion of which are now being used as collateral for indebtedness. The company has but one accommodation loan of $3.500, the balance of the debt being for vouchers and bills payable for material. As illustrating the growth of the business, it is stated that last month the number of 16 candle-power lamps on the circuit amounted to 20,134 and for the corresponding month the preceding year, 11,508, an increase of 75 per cent. Comparing the net earnings for the same period there was an increase of 127 per cent. For the three months ending December 31st, 1890, the net earnings were $11,588, equal to $46,308 per year, or 9$\frac{3}{10}$ per cent. upon the capital.

POSTAL TELEGRAPH CABLE CO.

At the annual meeting of the Postal Telegraph Cable Company, about 80 per cent. of the stock was voted and these directors were chosen: John W. Mackay, George S. Coe, W. C. Van Horne, John W. Mackay, Jr, Albert B. Chandler, Charles R. Hosmer, James W. Ellsworth, William H. Baker, Edward C. Platt, John O. Stevens, and George G. Ward. All these gentlemen were reelected except the younger Mr. Mackay. The executive committee now consists of Messrs. Coe, Platt, Ward, and Chandler.

Mr. Hector De Castro has resigned his office in this company and also in the Commercial Cable Company. He has been appointed secretary of the International Union of American Republics, which is looking after the Interoceanic Railway project.

ADAMS ELECTRIC CO.

The trustees of the Adams Electric Company, of St. Louis, Mo., have decided to pool the stock for ten years, and have elected the following gentlemen trustees of the pool: Prof. Francis E. Nipher, Hugh Rogers, and Dr. I. G. W. Steedman. This is the original company, with a capital of $25,000. The organization of a new company will soon be effected at Springfield, Ill., with a capitalization of $5,000,000, divided in 200,000 shares. A great portion of this capital stock is represented by the alleged value of Dr. Wellington Adams' patent covering the transmission of electric power, whether from overhead wires, storage battery or conduit, to the electric motor of street railway cars or to any electric motor.

ORGANIZATION OF THE AMERICAN PROJECTILE COMPANY.

The directors of the Thomson Electric Welding Company have decided to organize the American Projectile Company, with a capital of $500,000, for the manufacture of projectiles for the army and navy departments of the United States Government. The articles of incorporation will be prepared at once. The plans of the new factory at Lynn are in readiness, and within sixty days it is expected that the building will be erected and stocked with necessary machinery. The present contracts are to be filled within the ensuing six months. The necessary experimenting has already been done and the factory will start at once upon the regular manufacture of these projectiles. The rights will be given to the stockholders of the Thomson Electric Welding Company to subscribe at par to the stock of the new Projectile Company.

STANDARD ELECTRIC TIME CO.

At the annual stockholders' meeting of the Standard Electric Time Company, the following directors were elected: C. D. Warner, A. W. Paige, and Thomas Wallace, of Ansonia; Frank E. Morgan and Maj. T. Atwater Barnes, of New Haven; H. L. Wade and M. L. Sperry, of Waterbury. C. D. Warner was reelected president, and Geo. W. Huntington, secretary and treasurer.

This company has now 85 isolated, and 16 city plants in operation. Its headquarters will be changed from Waterbury to New Haven, and the business concentrated at that point.

OFFICERS OF THE STANDARD UNDERGROUND CABLE CO.

The board of directors of the Standard Underground Cable Company elected at the annual meeting of the company on January 27th, met Feb. 2, 1891, in the company's office, Westinghouse building, and organized by electing Joseph W. Marsh as vice-president and general manager; Frank A. Rinehart as secretary and treasurer and Oscar R. Ebel as auditor. An executive committee was also created, consisting of John H. Dalzell, Mark W. Watson and Robert Pitcairn, the president or vice-president being ex-offico members.

The promotion of Mr. Marsh is especially gratifying to his many friends, who have watched his career, and who know how thoroughly his long and able management of the business entitles him to the advancement now so gracefully accorded him.

ELECTIONS.

Salem, Mass.—At the annual meeting of the Salem Electric Light Company the old board of directors was re-elected.

St. Louis, Mo.—At a recent meeting of the St. Louis Electric Supply Company, the following directors were elected: H. H. Reese, H. C. Scott, E. Ruebel, and W. L. Scott.

Reading, Pa.—The stockholders of the Reading Electric Light and Power Company have elected the following officers for the ensuing year:—President, James A. O'Reilly, Esq.; secretary and treasurer, J. K. Kighter; directors, James Nolan, Levi Quier, Jesse Orr, Jerome L. Boyer, O. W. Stager, James A. O'Reilly, Esq., F. S. Hastings; auditing committee, George Eltz, Franklin A. Tyson, and W. W. Light. During the year two new boilers and two dynamos have been added.

Denver, Col.—At the annual meeting of the stockholders of the Denver and Berkeley Park Rapid Transit Company, the following officers were elected:—President, Frank Evans; secretary, W. G. Evans; and in addition to the foregoing C. F. Musgrove, C. K. Durbin and J. C. Curtis as a board of directors for the ensuing year.

Northampton, Mass.—At the annual meeting of the electric lighting company, the following officers were elected:—President, Alexander McCallum; treasurer, C. H. Pierce; directors, S. B. Fuller, H. A. Kimball, A. McCallum, E. C. Davis, C. H. Pierce. A 5 per cent. dividend was declared.

Woburn, Mass.—Mr. G. S. Russell has been elected assistant treasurer of the Johnston Electric Train Signal Company.

San Francisco, Cal.—At the annual meeting of the stockholders of the Sunset Telephone and Telegraph Company, the following directors were elected for the ensuing year:—John I. Sabin, president; Monroe Greenwood, vice-president; John E. Hudson, Oliver Eldridge, J. C. Cebrain, E. S. Pillsbury, Fred W. Eaton; also William G. Oliver, secretary and treasurer, and Percy T. Morgan, auditor. And at the same place and day the annual meeting of the stockholders of the Pacific Telephone and Telegraph Company, was held and the following directors were elected for the ensuing year:—John E. Hudson, president; Oliver Eldridge, first vice-president and general manager; Lloyd Tevis, W. F. Goad, Fred W. Eaton and E. C. Pillsbury; also William G. Oliver, secretary and treasurer, and Percy T. Morgan, auditor.

Toledo, N. Y.—The Toledo Electric Company has elected the following officers and directors:—President, E. W. Wilson; vice-president, L. S. Baumgardner; secretary and treasurer, F. B. Dodge; manager, N. C. Stevens. Directors, E. W. Wilson, L. S. Baumgardner, George G. Hadley, J. S. Rodgers, F. B. Dodge, James H. Doyle, A. W. Scott, N. C. Stevens, W. P. Heston.

New York, N. Y.—The Edison Electric Illuminating Co. have elected by unanimous vote, the following directors for the ensuing year: J. E. Brown, E. Crowell, C. E. Crowell, E. A. Doty, F. S. Hastings, C. N. Hoagland, Samuel Insull, D. R. James, Martin Joost, W. H. Murtha, E. Packard, G. F. Peabody and C. M. Pratt.

Kansas City, Mo.—At a recent meeting of the Missouri and Kansas Telephone Company, directors were elected for the ensuing year as follows: S. A. Walker of St. Joseph, George Albree of Chicago, C. E. Yost of Omaha, J. S. Chick and W. B. Clarke of Kansas City, T. B. Sweet and J. R. Mulvane of Topeka, J. E. Hudson of Boston and E. E. Cook of Davenport, Iowa. The following officers were elected: J. R. Mulvane, president; W. W. Smith, secretary; N. R. Ferguson, treasurer; C. W. McDaniel, superintendent; H. W. Crabb, assistant superintendent. J. R. Mulvane, George Albree and J. S. Chick were appointed the executive committee. A dividend of 1 per cent. was declared payable Feb. 10.

Wissahickon, Pa.—The Wissahickon Electric Light Company, at its annual meeting, has elected the following board of directors: President, William Johnston; vice-president, Peter P. Leibert; secretary and treasurer, John Flanagan; James Christie, Leander M. Jones, Andrew Flanagan, and George C. Thompson.

Rochester, N. Y.—At the annual meeting of the Rochester Railway Company, the following directors were elected for the ensuing year: H. Sellers McKee, Pittsburgh; M. A. Verner, Buffalo; E. E. Denniston, Richard M. Clay, Horace Magee, T. De Witt Cuyler, Philadelphia; Benjamin Graham, New York; A. G. Yates, Frederick Cook, W. S. Kimball, A. Luetchford, M. H. Briggs, J. N. Beckley, Rochester. The new board of officers is as follows: President John N. Beckley; vice-president, Benjamin Graham, of the banking firm of John Paton & Co., of New York; secretary and treasurer, Arthur Luetchford; general manager, C. K. Minary.

Shippensburg, Pa.—The Shippensburg Electric Light Company has elected the following directors and officers: Directors, G. W. Thrush, J. C. Rummel, David Gettle, Frank B. Fleming, S. A. Angle, W. W. Stough, James C. Fleming. Officers: G. W. Thrush, president; Frank B. Fleming, secretary; Clarence J. Reddig, treasurer.

Salem, Mass.—The Salem Electric Light Company has elected the following directors: Charles H. Price (president), James F. Almy, I. P. Harris, George M. Harris, S. Fred Smith, Z. A. Gallup, and B. W. Currier, of Lynn.

Fremont, O.—The Fremont Electric Light & Power Co. has elected Frank Heim, president; D. A. Rauck, vice-president; W. H. Ford, secretary and treasurer; W. M. Adams, superintendent.

Detroit Motor Company.—The annual meeting of the stockholders of the Detroit Motor Company was held recently, when the following directors were elected: W. C. Maybury, J. Huff Jones, E. T. Hance, Chas. W. Casgrain, W. H. Ellis, T. B. Rayl and F. A. Blades. The reports of the officers showed a marvelous growth in the business of the company in the last year. The plant just completed is as perfect as that of any electric company in this country.

New Britain, Conn.—The New Britain Electric Light Company at its annual meeting re-elected the old board of directors and chose the following officers: John M. Spring, president; L. C. Whitney, secretary; R. J. Vance, treasurer; and Samuel Bassett, auditor.

Albany, N. Y.—The Troy and Albia Railroad Company has elected the following officers for the ensuing year: President, Charles Cleminshaw; vice-president, A. N. Brady; secretary and treasurer, J. J. Hagen.

Philadelphia, Pa.—The Edison Electric Light Company's stockholders have elected as directors, Samuel B. Huey, D. S. Lindsay, John Lucas, Arthur Colburn, Joseph P. Ord, Amos R. Little, Charles M. Swain, William T. Tiers, Frederick Prime, George B. Woodman and R. F. Work. The board was later organized by the election of Frederick Prime, president; Samuel B. Huey, vice-president, and A. V. Sloan, secretary and treasurer.

STOCKS AND BONDS.

Increase of the Troy and Albia Railroad Company's Capital.—The application of the Troy and Albia Horse Railroad Company for permission to increase its capital stock from $50,000 to $400,000 has been approved by the State Railroad Commission. It is stated that the cost of construction and equipment of the road to date is $83,793; that the amount of capital stock outstanding is $44,700; and the amount of bonds outstanding, $34,000. The cost of construction aud equipment to date is apparently $5,995 in excess of the outstanding obligations. The cost of construction and equipment for the electric operation as proposed is put at $241,000; that for the proposed new road through the fifth ward and Hoosick street, 2½ miles, $175,000, making a total of $416,400.

Boston, Mass.—The report that the Thomson-Houston Co. is acquiring the Westinghouse Co. is denied. Westinghouse stock has advanced to 16¼.

Canton, O.—The Canton Electric Light and Power Company, of Canton, O., has increased its capital stock from $50,000 to $100,000.

Appleton, Wis.—The city of Appleton, Wis., will issue bonds to the amount of $43,000 for the purpose of installing a street lighting plant.

New Iberia, La.—The stockholders of the Electric Light Company of this place met last week for the purpose of raising the necessary funds to cancel an outstanding indebtedness. The reports showed that 178 shares of the stock had been taken, and 22 shares not taken; that there was a debt of $1,850 to be paid, and that with the amount which would be realized from the sale of these shares, together with the cash on hand, the debt could be paid. In accordance with this report the 22 shares were offered at their face value on three and six months and in less than fifteen minutes were taken up. There is no stock for sale now at less than a premium.

DIVIDENDS.

Lowell, Mass.—At a recent meeting of the directors of the New England Telephone and Telegraph Company, a dividend of $1.25 per share was declared, payable on Saturday, Feb. 14, 1891, to stockholders of record at the close of business on Saturday, Jan. 31, 1891. The transfer book will be closed from Feb. 1 to Feb. 14, 1891, both days included.

Cambridge, Mass.—The Cambridge Electric Light Company has declared a semi-annual dividend of 3 per cent. payable Feb. 2.

Boston, Mass.—The Erie Telephone Company has declared a quarterly dividend of one per cent. payable Feb. 16 to stockholders of record Feb. 7, transfer books closing at 12 M., Feb. 7, and reopening Feb. 16.

Boston, Mass.—It comes from semi-official sources that the Thomson-Houston Electric Company has the money in bank to declare a dividend on the common stock, and that the same will be declared payable about February 1.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEB. 3, 1891.

Accumulators :—

Secondary Battery. H. T. Cheswright, 445,542. Filed Apr. 14, 1890.
Electrode consists of a number of lengths of ribbed pipes of lead or alloy held in a suitable frame and having the intervals between their ribs charged with lead oxide.

Electrode for Secondary Batteries, S. H. Barrett, 445,872. Filed Nov. 1, 1890.
Electrode consists of a frame having a series of dividing ribs or partitions which are flush with the face of the plate, and divide the frame into a series of openings, together with a further series of partitions or ribs flush with one face of the plate and below the other face of the plate, and which subdivide the above-mentioned openings into a series of smaller openings.

Alarms and Signals :—

Electric Signaling Device, S. J. Burrell and W. H. Markland, 445.538. Filed June 4, 1890.
Relates to systems of signaling in which any one of a number of stations upon a circuit may call or signal to any other station only; as for instance, the case of a number of telephone stations upon a single circuit; also applicable to railroad service, as for the despatching of trains or the giving of other orders. Embraces devices for avoiding the disturbance or operation of the instruments at stations other than the one it is desired to communicate with.

Non-Interference Signal-Box, M. G. Crane, 445,545. Filed Nov 22, 1889.
Designed to render the signaling mechanism inoperative if at the moment that it is desired to transmit a signal the line be in use. Employs a movable connecting plate which controls the operation of the signaling mechanism, and a non-interference magnet operating to move the connecting plate.

Electrical Station-Indicator, E. S. Ely, 445,773. Filed May 28, 1890.
Electro-magnetic mechanism, controlled by a push button or similar device, to roll a strip containing the names of stations and exhibit each as required.

Successive-Non-Interference Signal-Box, F. W. Cole, 445,795. Filed Nov. 22, 1889.
An independent time-train is employed to move the clog, stop, or hold-fast in one direction; it is moved or held in the opposite direction by a spring or its equivalent, both movements being under the control of a non-interference magnet.

Electric Visual Indicator, F. W. Cole, 445,796. Filed March 7, 1890.
Designed to display many different numbers for fire-alarm and other similar purposes, and consists of details of electro-magnetic apparatus for actuating a series of drums having numbers upon their surfaces.

Repeater, F. W. Cole, 445,797. Filed April 12, 1890.
An automatic repeater adapted to be used in non-interference fire-alarm systems or other similar electric circuits.

Successive Non-Interference Signal-Box, F. W. Cole, 445,798. Filed May 16, 1890.
The retarding or non-interference devices of several boxes on a circuit are arranged to take different periods of time for their operation; so that if several boxes are operated at or about the same time the first one which opens the circuit will obtain the line and the rest will be held till the first signal be completed, when the box having the next shortest time-retarding device will follow with its signal and so on.

Non-Interference Signal-Box, F. W. Cole, 445,799. Filed May 29, 1890.
The power of the non-interference magnet is controlled by a switch, which is in turn controlled by the box-door. This is to prevent the armature responding to the impulses from another box when the home box-door is open.

Successive Non-Interference Signal-Box, F. W. Cole, 445,800. Filed May 31, 1890.
Details of construction and operation.

Successive Non-Interference Signal-Box, F. W, Cole, 445,801. Filed Nov. 14, 1890.
Contains a windable signaling mechanism, a non-interference magnet, means for sending a signal and means for retaining the set signal when the line is in use, and means for releasing the signaling mechanism on a closure of the signaling circuit of duration longer than the longest closure employed in any signal.

Successive Non-Interference Signal-Box, F. W. Cole, 445,802. Filed Oct. 10, 1889.
Contains a stop for the signaling mechanism, a restorer for normally holding the stop-lever in position to lock the signaling mechanism, a non-interference magnet, a retarding device and a clog controlled by the non-interference magnet and acted on by the retarding device for holding the stop-lever in position still to lock the signaling mechanism after it has been released by the restorer.

Electric Fire-Indicator, T. R. Douse, 445,931. Filed Nov. 1, 1890.
A thermostat actuated by heat-expansion of air, alcohol, mercury or other agent hermetically enclosed in a box. Electric contacts are closed by the expansion of the box, the top and bottom of which are corrugated. Thermometric markings are provided by which the apparatus can be set to act at any given temperature.

Conductors, Conduits and Insulators :—

Electric-Conductor Support, C. Foster & W. H. Bevis, 445,594. Filed July 30, 1890.
Especially applicable to overhead conductors for electric railways.

Wire-Covering Machine, J. McCahey, 445,598. Filed April 15, 1890.
An improved winding machine for covering electric or other wires.

Electric Wire Connector, J. W. Hoffman, 445,751. Filed Aug. 22, 1889.
Epecially applicable to joining, between the cars, the conductors employed in lighting railway trains.

Insulator, H. D. Winton, 445,790. Filed July 23, 1890.
A "break" insulator especially designed for looping a circuit of electric lamps, telephones or other translating devices. Applicable to overhead wires. Metallic hooks, cross-heads, or equivalents are molded, cast or otherwise embedded within the block of insulating material in such a manner that they interlink within the material without coming in contact with each other.

Dynamos and Motors :—

Electric Motor, F. J. Patten, 445,623. Filed Oct. 6, 1890.
An alternating-current motor. Consists substantially of two independent machines, the armatures of which are upon a common spindle; the field-magnets are connected to separate sources of alternating-currents; the supply circuits are periodically and alternately short-circuited by groups of commutator segments suitably connected together. The principle of the invention is summed up in claim 8 as follows: The described method of utilizing alternating currents in the transmission of energy which consists in converting currents into two independent like sets of secondary currents and causing these two to successively excite the operative circuits of the machine.

Electric Motor, F. J. Patten, 445,624. Filed Oct. 18, 1890.
Amplification of No. 445,623 above. Claim 10 follows: The method of operating electric motors on alternating-current circuits, which consists in connecting the operative circuits of two independent machines, the rotary parts of which are carried by a common spindle to a source of alternating current through commutators that short-circuit or cut out the exciting-circuits of each machine in turn during the period of time that the circuits of the other are excited by the current from the source of supply.

Electric-Motor Switch, F. A. Weller, 445,741. Filed Feb. 1, 1890.
Relates to means for starting and stopping electric motors on constant-potential circuits and adapted to graduate the rush of current through the motor upon starting and to break circuit promptly for stopping. Establishes the main line current through the field coils in advance of establishing the circuit through the armature coils, and employs resistance coils in connection with the switch for graduating the initial flow of current.

Dynamo-Electric Machine. C. J. Schwarze, 445,906. Filed Oct. 2, 1890.
Relates to the form and construction of the field magnets. The frame, field-magnet, cores and pole-pieces are integral with each other; the sections of the frame used as cores are rectilinear lengthwise and cylindrical in section.

Starting Device for Electric Motors, E. P. Sharp, 445,907. Filed March 18, 1890.
For controlling and graduating the current passing through the motor at starting and for indicating any failure of such control or graduation. Consists in a rotary mechanism combined with a series of resistance-coils and contacts, by which the resistances are cut out of circuit one after another; employs an electric lamp or other signal so connected as to be brought into action by any abnormal increase of current.

Ignition :—

Electric Gas-Lighting Apparatus, H. H. Cutler, 445,727. Filed May 6, 1890.
Relates chiefly to a circuit-closer for gas-lighting apparatus employed in lighting street lamps.

Electric Gas-Lighter H. H. Cutler, 445,728. Filed March 15, 1890.
For lighting street lamps. Comprises appliances for turning on and lighting the gas and for turning off the gas, and adapted for including in one circuit, in series, a large number of lamps. Employs powerful currents such as those used in electric lighting.

Lamps and Appurtenances :—

Electric-Arc Lamp, J. W. Easton, 445,546. Filed Feb. 19, 1890.
Employs a rack and pinion feed. Contains an escapement wheel controlling the pinion, a pivoted frame on which the escapement wheel is mounted, an escapement mounted on the fixed frame of the lamp, and means for adjusting the position of the axis of the escapement, by which the lamps may be arranged to burn at any desired voltage.

Mast-Arm for Electric Lights, G. Fitch, 445 549. Filed July 3, 1890.
Claim 1 follows:
In a mast-arm, the combination of a main arm pivotally connected at the inner end, and a secondary counter-weighted balancing arm pivoted at a point below and connected to the main arm by equalizing links and levers.

Cut-Out for Incandescent Lamps, T. D. Bottome, 445,686 Filed July 25, 1889.
Lamp has a straight filament mounted at right angles in two spring-arms having a portion of their inner adjacent faces near the ends carrying the filament, normally separated so long as the filament remains intact, and adapted to close the circuit upon the rupture of the filament.

Incandescent Electric Lamp, T. D. Bottome, 445,688. Filed Nov. 8, 1890.
Relates to the conductors or leading-in wires of incandescent lamps. Employs an alloy of silver, platinum and nickel or cobalt.

Electric-Arc Lamp, O. C. White, 445,724. Filed Nov. 7, 1889.
The clamping-blocks, formed like sections of a ball or sphere, are enclosed in two opposing rings forming sockets within which they are capable of turning; the tension of a spring is employed to bring the enclosing rings together and compress the clamping blocks.

Electric Switch, J. W. Hoffman, 415,752. Filed Feb. 4, 1890.
A switch especially applicable for electric lighting and particularly designed to prevent sparking, by exceedingly quick action.

Electric Cut-Out, G. A. Scott, 445,822. Filed Aug. 13, 1890.
A fusible cut-out for electric lighting circuits.

Reel for Raising and Lowering Electric Lamps, J. T. Roberts, 445,908. Filed July 26, 1890.
Special contrivance of brake mechanism and devices for attaching or supporting the reel.

Electric Switch, G. R. Lean, 445,957. Filed March 24, 1890.
Especially applicable to lighting and power circuits and adapted for switching a loop into and out of circuit with a main line wire.
Claim 1 follows;
In an electric switch, two main line blocks and a switch between them, two branch line blocks and a switch between each branch line block and the main line blocks, the movable members of the branch line switches operating in advance of the movable members of the main line switch at every movement thereof.

Medical and Surgical :—

Electrical Medical Apparatus, J. C. Chambers, 445,636. Filed April 21, 1890.
A combination of a battery, induction-coils and other suitable apparatus and appliances for administering electricity in a variety of ways, and all mounted in a cabinet suitable for a physician's office.

Metal Working :—

Method of Electric Soldering and Cementing Cans, M. W. Dewey, 445,770. Filed Sept. 27, 1890.
Consists in heating the soldering-tool by passing an electric current through a conductor in close proximity or contiguous to the tool while it is remote from the work, and then moving the tool from the conductor and into contact with the work.

Apparatus for Soldering and Cementing Cans by Electricity, M. W. Dewey, 445,771. Filed Sept. 27, 1890.
Details of apparatus for carrying out the method of patent No. 445,770 above.

Miscellaneous :—

Apparatus for Electric Branding, W. Cannell, 445,648. Filed April 8, 1890.

Employs a high resistance branding-plate, largest in the middle and of gradually diminishing cross section toward the opposite ends and forming a portion of the secondary circuit of an electric transformer.

Apparatus for Testing Metal Pieces, L. De Place, 445,860. Filed Nov. 11, 1890.

Application of the "Schiseophone" to the detection of flaws in metal. Claim 1 follows :

An instrument for testing metal objects, comprising, in combination, a microphone or telephone transmitter in an electric circuit, including a coil or helix, a striker in close proximity to said microphone, a secondary coil or helix, and a telephone receiver in circuit therewith.

Asymmetrical Electrical Resistance, T. D. Bottome, 445,687. Filed Jan. 28, 1890.

A resistance device through which the current will flow freely when passed in one direction but will be resisted or nearly stopped when applied in a reverse direction. Consists, essentially, in an electro-chemical apparatus having conducting plates of chemically inoxidizable metals immersed in a conducting fluid consisting largely or entirely of sulphuric acid or a solution of a sulphate; one of the conducting plates being composed of metallic aluminum.

Railways and Appliances :—

Automatic Circuit-Closing Device for Railroad Signals, I. W. Loy and R. O'Toole, 445,564. Filed April 12, 1890.

Relates to the design, construction and operation of circuit closers placed beside a railroad track to be actuated by passing trains.

Rolling-Stock for Tramways or Railways, C. Zipernowsky, 445,583. Filed Sept. 22, 1890.

Relates to the mounting of motors upon railway trucks and to the arrangement of driving gear. The motor has its field-magnet sleeved on extensions of the axle-boxes of the driving-axle at one end and is supported by a movable connection to the body of the vehicle at the other end. The motor is mounted with its armature shaft longitudinal with the car and is connected to the driving axle by a worm-gear and a toothed gear upon the driving axle.

Contact Device for Electric Railways, E. M. Bentley, 445,634. Filed Sept. 20, 1888.

For conduit electric railways. Specially adapted for convenient and ready removal from the conduit and replacement, as required at "cross-overs."

Electric Semaphore, F. Stitzel and C. Weinedel, 445,653. Filed Dec. 21, 1889.

A system of apparatus and circuits for the operation of railway signals, adapted to the "block" system.

Regulator for Electrically-Propelled Vehicles, S. H. Short, 445,654. Filed Oct. 17, 1890.

Claim 8 follows :

An electrical regulator comprising a reversing switch and an adjustable rheostat or intensity-regulating means, together with two movable operating devices mechanically connected, one with the reversing switch and the other with the rheostat, and having said devices each insulated from the current to be regulated and each in electrical connection with the ground.

Electric Railway, R. M. Hunter, 445,674. Filed Jan. 14, 1889.

Relates particularly to contact-devices or collectors on the car for use in conduit systems, and especially adapted to a conduit outside of the track.

Coupling for Trolley-Wires of Electric Railways, S. H. Short, 445,841. Filed Oct. 29, 1889.

The connector has grooves for the reception of the wires, and inclined holes extending through the coupling in such a manner that the ends of the wires may be bent over or otherwise secured at the top of the connector.

Trolley-Wire Holder, E. P. Sharp, 445,908. Filed Sept. 25, 1890.

Wraps the trolley-wire with a thin and ductile metal strip secured to the holder by a single joint on the upper side.

Electric Railway, R. M Hunter, 445,952. Filed Sept. 28, 1886.

Claim 1 follows :

In an electric railway, the combination of a line conductor extending along the railway, electrically propelled cars moving on said railway and receiving current from the conductor, an electric generator for supplying current to said line conductor, and two or more feeding conductors connecting one pole of the generator with different distant parts of the line conductors.

Electric Car-Lighting, L. F. Jordan, 445,954. Filed Nov. 16, 1889.

System of circuits and appliances for car lighting, especially applicable to electric railway cars, and embracing details of devices for electrical connections between cars when made up in trains.

Telegraphs :—

Autographic Telegraph, H. Etheridge, 445,715. Filed March 7, 1890.

Relates to improvements in transmitters for autographic telegraphs of the variable resistance type employed by the Writing Telegraph Company.

Automatic Switch for Autographic Telegraphs, H. Etheridge, 445,716 Filed Oct. 29, 1888.

Relates to means for controlling the circuits between subscribers and the central office in an autographic telegraphic exchange system.

Telephones and Apparatus :—

Telephone Box or Cabinet, B. A. Stevens, 445,721. Filed May 26, 1890.

A cabinet for telephone subscribers provided with sound-deadening walls and ceiling and with sound-vents which may be closed while the subscriber is talking, and be left open at other times to permit a call to be heard outside.

Appointments, Etc.

Mr. Edward Lewis has been appointed superintendent of Middletown Electric Light Company, of Middletown, Conn.

Mr. E. G. Pike has been appointed superintendent of the telephone service of Upper Peninsula of Michigan.

Mr. Charles A. Gates has been appointed superintendent of the telephone exchange at Jackson, Mich.

Mr. B. J. Arnold, who has represented the Thomson-Houston Electric Co. as agent and engineer at St. Louis during the past eighteen months, has been appointed consulting engineer for the Western department with headquarters at Chicago.

Mr. H. K. McCay, for three years manager of the Edison Elec. Ill. Co., of Birmingham, Ala., has accepted the position of manager of the Amsterdam Elec. St. Ry. and Edison Elec. Lt. & Power Co., of Amsterdam, N. Y.

Legal Notes.

THE EDISON COMPANY SUED.

Arthur D. Johnson, of Lynn, has brought suit against the Edison General Electric Company for $30,000 damages. On the 11th day of October he was in the employ of the Edison Company, at Salem, Mass., and while at work on the platform of a tower wagon, adjusting a trolley-wire, fell to the ground, a distance of sixteen feet, and sustained serious injuries. The fall was occasioned by the breaking of a bracket used for the purpose of drawing an electric wire taut, and because of the wagon platform not being sufficiently guarded with a railing.

G. F. CORLISS vs. THE MANSFIELD ELECTRIC STREET R.R. CO.

Suit has been filed against the Mansfield Electric Street Railroad Company, of Mansfield, O., by G. F. Corliss, claiming $300 damages for the use of his patent. He is the patentee of a spiral spring, his letters patent bearing the date of April 29th, 1890. The spring is placed in boxes on the cars to keep the wire taut which draws the double trolley. Corliss was in the employ of the company about a year ago, at which time he invented the spring. It has been in constant use ever since. The car company will fight the case.

AN ADVERTISING COMPANY'S SUIT FOR DAMAGES.

A novel suit has been brought by an advertising company against the electric street railway company, of Peoria, Ill. Indicators containing advertisements and "next street" were put in the cars and there was an agreement made that the curtain should be pulled every block, but it would seem from this suit that this has not been done, and advertisers have brought suit for $5,000 damages. The outcome of this suit will be noted with interest by the public for the reason that when it comes to trial the various and multifarious duties of a conductor on a car will be defined.

THE BOSTON SUBURBAN LIGHT AND POWER COMPANY'S PETITION DISMISSED.

An important decision has been rendered by the full bench of the Supreme Court in the case of the Suburban Light & Power Company against the Board of Aldermen of the city of Boston.

These were petitions for an order directing the defendants to specify in writing where in the highways of the city the petitioner might erect poles to enable it to perform an alleged contract made with the city for lighting certain streets. Both petitions are dismissed, and the opinion, which was written by Judge Devens and approved after his death by the other justices, clearly defines the power of boards of aldermen and selectmen to regulate the use of streets in connection with electric lighting companies.

SETTLEMENT OF AN ELECTRIC RAILWAY INJUNCTION.

A settlement has been effected between the Southern Railroad Company and the Union Depot Railroad Company, of St. Louis, Mo., in regard to the occupancy of a track on Ninth street, between Russell and Lafayette avenues. Both companies use the same track in the locality named, but when the Southern began to string electric wires the Union Depot Company applied to the Circuit Court for an injunction, claiming that two electric railroad companies could not use the same track at the same time. A stipulation was filed by which the case has been dismissed. It was agreed that both companies should use the same track and the same wire in the disputed locality by a system of cut-offs and switches which are set out in full.

T. W. PEARSALL vs. WESTERN UNION TELEGRAPH CO.

The Court of Appeals has rendered a decision in the case of T. W. Pearsall against the Western Union Telegraph Company, affirming the judgment of the lower court in favor of the plaintiff. This was an action to recover damages for the alleged negligence of the defendant in failing accurately to transmit a telegraphic message from Great Neck, L. I., to New York. On July 31, 1884, some person on behalf of the plaintiff delivered to a telegraph operator at the station of the Long Island Railroad at Great Neck, without prepayment, a message for transmission to New York, addressed to "T. W. Pearsall & Co.," telling them to buy 1,000 shares of Western Union. This message was written, not upon one of the printed blanks of the company, but on an ordinary sheet of note paper, with no conditions whatever printed thereon.

The message was delivered at the place directed and paid for, but the words "& Co." had been omitted, the address reading simply "T. W. Pearsall." No person in the office of the firm possessed authority to open a message thus addressed, consequently the telegram remained unopened until Mr. Pearsall arrived. In the meantime the price of Western Union had gone up, and when the plaintiff purchased the stock on his return to the city he had to pay a higher rate than if it had been purchased at the time he telegraphed. He sued for the amount represented by the advance in price, recovered judgment, and the Court of Appeals now affirms the judgment.

THE McKEESPORT ELECTRIC LIGHT CO.

A bill in equity has been filed by the Edison General Electric Company, the Edison Light Company, Samuel Insull, Thomas Petty and F. H. Busch, against the McKeesport, Pa., Light Company, Thomas L. White, president and director, and Thomas Reynolds, James E. White, Henry Reiber and James S. Kuhn, acting directors.

The plaintiffs, it is asserted, own 1,065 shares of the 1,843 shares of stock issued by the McKeesport Light Company. At the annual meeting on October 14, 1890, an amendment to the bylaws was passed increasing the number of directors from five to seven. The directors and White, who comprised the minority stockholders, obstructed the business of the meeting, preventing an election, with the intention of remaining in office indefinitely. A call for a special meeting was refused and an application was made to court for a mandamus on the president to call a special meeting. The mandamus was refused, but the opinion of Judge Ewing was strongly in favor of the plaintiffs. On the strength of the opinion White then called a special meeting. The plaintiffs were present, but of the minority stockholders only White and Secretary Reiber, representing 41 shares, were present. This left them without a necessary quorum of two thirds of the stock, as required by the by-laws, and White declared they could not hold an election.

The plaintiffs say that though they have a lawful right to control the affairs of the company, they are not represented on the board of directors and have no share in the management. They therefore ask that a receiver be appointed to take charge of the business, and that the defendants be restrained from exercising the functions of officers or interfering in any way with the business.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Back up your 'drummers' with live advertising."

BAIN ELECTRIC MANUFACTURING CO.

Mr. Forée Bain, the well-known electrical manufacturer and expert of Chicago and one of the pioneers in many of the branches and recent developments in electrical mining and power transmission work, has recently incorporated his old and long established business under the name of Bain Electric Mfg. Co. This action has been rendered necessary owing to the large demand for his dynamos and motors, which he will now manufacture in large quantities, keeping all sizes in stock and will immediately remove to No. 47 and 49 S. Jefferson street, where he has secured very extensive and commodious quarters which will be immediately equipped with the latest and most improved machinery for heavy work, such as building 500 h. p. motors and dynamos for distribution of light and power. Mr. Bain is president and engineer of the company, and as heretofore will devote a considerable portion of his time to expert consulting electrical work and also to the application of electricity to all industrial and new uses. He will also pay attention to supervising the building and equipment of electric street railways in which line his name has become widely known in connection with the vast enterprise of this kind in Minneapolis and St. Paul, and it is in a large measure due to his intelligent supervision and the perfection in detail which he has had carried out there, that the operation of that large system is so eminently successful.

HOTEL HANDBOOK.

The Traders and Travelers' Accident Co., of New York, have issued in very neat form, for carrying in the pocket, a hotel handbook and guide. It gives the name of the place, the hotels, their rates, and the population. The towns and cities are arranged alphabetically under their respective States, and the States are also arranged alphabetically, so that specific or general reference can be immediately made. The name of the State is also printed in prominent lettering at the top of each page. The book measures 5 x 2¾ inches, and has a flexible cover. At the end is a calendar for 1891. The price is 75 cents. It is well worth the money and should prove of value also to the company as a means of advertising their excellent system of accident insurance.

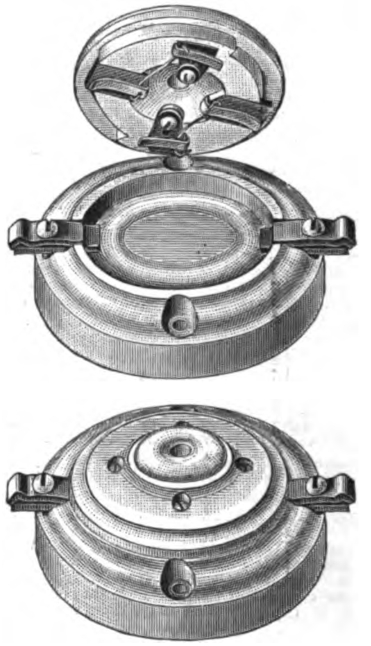
THE EMERSON SPRING CLIP CUT-OUT.

The Emerson Electric Manufacturing Co., of St. Louis, have just brought out a novelty in the shape of a ceiling block known as the "spring clip cut-out." The object has been to produce a cut-out of simple construction, easily fixed to the ceiling, and convenient for renewing the fuse wires.

The accompanying engraving, Fig. 1, shows the cut-out with the cap removed. To the base are attached the main terminals, which consist of two flat pieces of brass, which can be pressed together by means of slot headed screws. The mains are connected by simply stripping the insulation for the space of half an inch, slipping them into position between the plates and turning the screws. The plates project into the central opening and form catches, under which similar catches on the cap piece engage when placed in position. To the cap piece are attached four sprig clips, two of which are attached to, and form part of, the lamp terminals. These lamp terminals are provided with the usual slot-headed screws and washers, under which the flexible ends are attached. The other two spring clips are attached to, and form part of, the catches which engage with the two catches on the base, when placed in position.

The fuse wires are attached by simply slipping the ends under the spring clips of the catch plate, and lamp terminals, respectively, as shown in Fig. 1.

The cap is placed in position by pressing it into the central opening of the base and turning it to the right, until it engages the catch plates of the base. This action engages the springs with the annular ridge in the base and causes the spring clips to be pressed tightly against the fuse wire ends, slightly flattening them and insuring a good connection. This prevents the fusing that is incidental to defective contact. The spring clips which are attached to the catch plates also perform another important function; they slip into slight dents in the annular ridge, thus locking the cap into place and preventing the possibility of its becoming loose by vibrations. The engraving, Fig. 2, shows the cut-out complete with the cover in position.



Figs. 1 and 2.—The Emerson Spring Clip Ceiling Block.

EUREKA TEMPERED COPPER CO.

One of the Eureka tempered copper boxes was placed in the service of the Pennsylvania R. R. Co., between Kane and Renovo under tender of engine No. 2020, March 21, 1887, and taken out October 30, 1888, having made 96,347 miles. Box was in good condition and showed but little wear.

Another was placed in same service between Kane and Erie, Pa., and used over two years, and was taken off in good condition, showing no lateral wear and but little wear upon its face, having made 155,000 miles.

THE CENTRAL ELECTRIC CO.

Since the Central Electric Co. decided to go into the railroad supply business, they have been looking thoroughly into the subject, and announce that they will shortly be upon the market with some railroad specialties entirely their own. These will be announced and illustrated in due time.

AN ELECTRIC EXERCISING MACHINE.

The accompanying illustrations show a novel device manufactured by the American Electric Exercise Machine Co., of New York and Chicago.

Fig. 1 shows the machine in use, and its operation will be clearly understood by reference to Fig. 2, which shows the magneto-electric apparatus geared to the drums on which are wound the exercising cords. When the machine is in use a gentle current is generated by the operation of the magnet so that it may be graduated at will. The electric apparatus may, however, be disconnected, and the machine used as a simple health-lift, or, on the other hand, it may take the place of a medical battery and be used to supply a current alone.

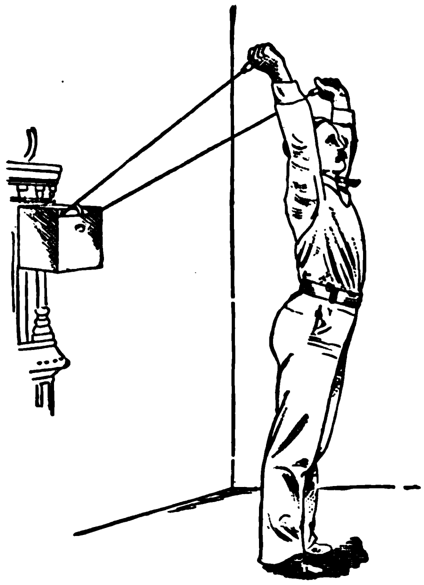
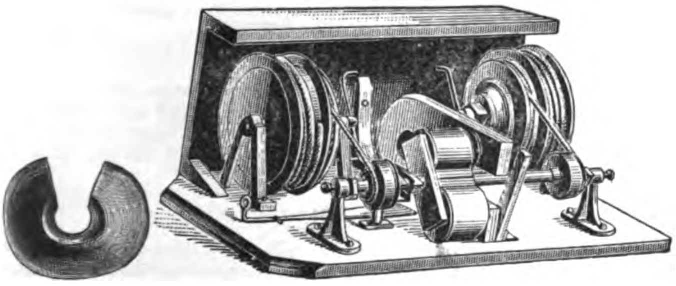


FIG. 1.—AN ELECTRIC EXERCISE MACHINE.



FIGS. AND 3.—AN ELECTRIC EXERCISE MACHINE.

The manufacturers claim that highly beneficial results are obtained by the use of the device, and especially recommend it to those whose occupations cause muscular pains in the hand or arm.

ELECTRICAL SUPPLY CO., CHICAGO.

The Electrical Supply Co., of Chicago, have received the following letter from the Mountain Electric Co., Denver: "In installing isolated plants throughout this state, we carefully investigated the various makes of rubber covered wire. After sending for samples of nearly every standard brand, we finally decided to use Habirshaw wire solely, for the reason that we consider it the best. To indorse this statement we think it only necessary to add that the cost of the wire is higher than any other wire quoted us. We are very glad to inform you that we shall soon send in an order for a large quantity of this wire, as we have recently obtained the contracts on three new buildings. Trusting that this will give you a practical proof of what we think of Habirshaw wire, we are, etc."

F. P. LITTLE & CO.

Mr. W. H. McDonald has severed his connection with the firm of Little, McDonald & Co., and the firm will be continued under the name of F. P. Little & Co., who assume all liabilities and to whom all bills due should be paid. The parties forming the new firm are F. P. Little, S. F. Eagan and P. P. Miller. The business will be carried on as before at 141 East Seneca street, Buffalo, N. Y.

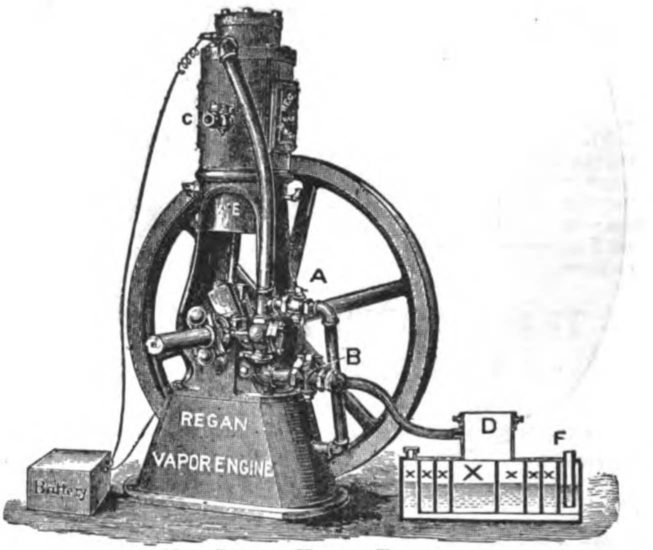
THE REGAN VAPOR ENGINE FOR ELECTRIC LIGHTING.

The increasing tendency to use gas instead of coal for motive power is clearly shown by the large number of gas engines now in use. The Regan Vapor Engine differs essentially from others of its class, inasmuch as it contains no flame igniting device, the charge being fired by a spark from an ordinary wet or dry battery, as described below. It can therefore be left to itself in a house, store or barn with perfect safety.

While gas can be used for fuel, the Regan engine runs as well with gasoline. The accompanying engraving illustrates the upright type of engine, showing the carburetor and small battery complete.

It is operated by means of vapor drawn into the cylinder by the suction of the piston, and ignited by an electric spark, as follows: The carburetor contains a small quantity of gasoline, and is connected with the engine by a pipe, as shown. At each revolution of the fly-wheel a current of cool air is drawn through the carburetor and into the cylinder. In passing through the carburetor, it vaporizes a quantity of the gasoline; this, when mixed with more air drawn through the pipe and air-valve, forms the charge which, upon combustion, develops the power.

On the return stroke the charge is compressed in the head of the cylinder, and just before the piston arrives at its highest point, or "upper dead centre," a shoulder or point projecting from it, which is an electrode, comes in contact with a flexible piece, also an electrode, the two comprising the poles of the small battery; thus completing an electric circuit which is broken just as the piston has passed its "centre" and commences to descend. At the instant the electrodes separate, the spark is emitted, firing the charge. On every other stroke of the piston this is repeated automatically, save when the supply is "cut off" by the governor, which not only controls the engine perfectly, but at the same time "cuts off" the supply of gas, so that when less power is being used, proportionately less gas or vapor is consumed.



THE REGAN VAPOR ENGINE.

The Regan vapor engine is built both upright and horizontal, from ½-h. p. upwards, both for stationary and marine purposes.

This engine is manufactured by Thomas Kane & Co., of Chicago, and is extensively used in California, where it was invented.

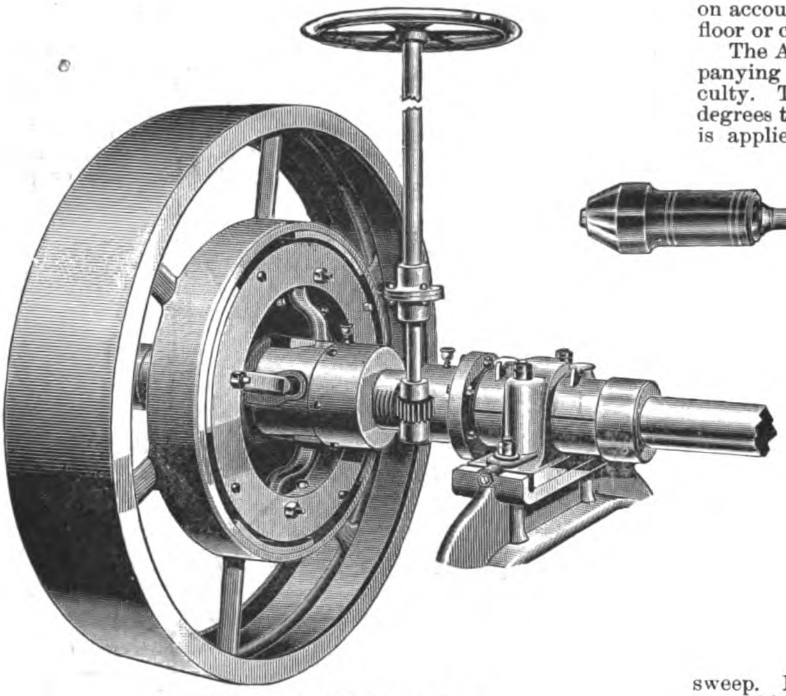
THE EMPLOYERS' LIABILITY ASSURANCE CORPORATION LIMITED.

Endicott & Macomber, the managers and attorneys of the above corporation in this country, have issued, from their Boston headquarters, a very handsome pamphlet setting forth its objects, and describing the insurance that it furnishes employers against injuries to workmen. It issues policies indemnifying against any compensation or damages that employers may be required to pay as the result of legal proceedings, or which, with the concurrence of the corporation, the employers may agree to pay in respect to accident to workmen. Issued in the same way are a variety of other policies, such as the Outside Liability, the "Workmen's Collective," the General Liability, the Elevator and General Accident. These comprehend, in their range, all the accidents that belong to modern life and methods of labor, and the company enjoys a large and increasing business as the result of its liberality and its well devised system. The insurance offered by the company may be heartily recommended to employers of labor in the electrical field.

RICE'S PATENT FRICTION CLUTCH PULLEY.

The friction clutch pulley herewith illustrated, was invented by A. C. Rice, superintendent of the extensive works of the Stilwell & Bierce M'f'g. Co., Dayton, Ohio. The engraving represents one of the pulleys in perspective, attached to a shaft and thrown into gear. The clutch is shifted in and out by means of an upright shaft terminating in a pinion which engages in a rack cut in the side of the shifter sleeve extension. This shaft is provided with a hand wheel, and may be extended so as to operate the clutch from any floor above or below. The ordinary shifter fork and lever can be used, and will be provided if preferred.

The clutch is provided with four metal friction shoes, which are simultaneously operated by the four crooked shifter arms. Each of these shifter arms is fulcrumed on an eccentric bolt, the end of which only is seen. The centre of each friction shoe is out of centre with its corresponding eccentric bolt, the effect of which is, that when the friction shoe is thrown out against the friction rim, the shoe acts as a wedge, increasing the friction of the two surfaces, just in proportion as the load is increased, thus effectually preventing all slip. Each shifter arm is provided with an anti-friction roll running in the inclined slots in the shifter sleeve, which makes it easy to operate. These inclined slots terminate at both ends in straight slots parallel with the shaft, which serve to lock the shifter arms and prevent all friction whatever on the shifter sleeve caused by centrifugal force when running, and consequently all tendency to throw in or out.



Rice's Friction Clutch Pulley.

This clutch is positive in action, very powerful in grip, perfectly balanced, does not throw out oil when running, is entirely free from clap trap attachments, and will be found durable and satisfactory in operation.

JAMES J. SMYTH & CO., OGDEN, UTAH.

The above pushing concern has just secured a franchise for a messenger and fire alarm system, for which it will use about 6 miles of Shield Brand wire. The system to be used has not yet been selected. Mr. Smyth writes us that he has just been wiring the new Opera House for 800 lights, using nothing but Okonite wire. He has other wiring work on hand, and says he would welcome a partner with about $2,000 capital and some experience to open up a first-class wiring house, and run the messenger system. Ogden, now a city of 20,000 inhabitants, has two electric light plants. The Citizens' Electric Light Co. has just completed a Westinghouse alternating plant of 2,000 incandescents and 50 arcs. The Ogden City Electric Light & Gas Co. is running 50 Brush arcs and 750 Heisler incandescents. It is also putting in a Thomson-Houston 1,500 light alternating plant, together with two 50 light Thomson-Houston arc machines.

Meadville, Pa.—The People's Incandescent Electric Light, Heat and Power Company has elected for the ensuing year the following officers: Dr. Cyrus See, president; Charles Fahr, vice-president; John Reitze, Jr., treasurer; F. R. Shryock, secretary.

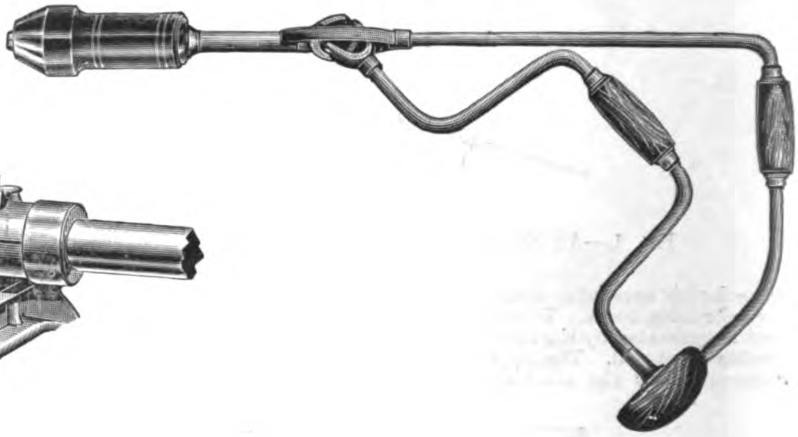
A NATIONAL ELECTRIC MANUFACTURING CO.'S PLANT.

The stockholders of the Centralia Electric Light & Power Co. held a meeting at the office of Capt. S. L. Dwight last week and elected a board of directors and officers. The following five gentlemen were elected directors:—S. L. Dwight, J. J. Wetmore, H. T. Cunningham, Jas. Benson, T. J. Wilson. The board organized by electing T. J. Wilson, president; S. L. Dwight, secretary and treasurer; James Benson, superintendent. It is the intention to turn on the light at once. They will start with 240 paying lamps, and have orders for about 140 more to be put in right away. The plant is alternating incandescent, put in by the National Electric M'f'g. Co., of Eau Claire, Wis.

THE AMIDON CORNER BRACE.

In electrical construction, great difficulty is often experienced on account of the necessity of boring in corners, and close to the floor or ceiling.

The Amidon corner brace, which is illustrated in the accompanying engraving, was designed especially to meet this difficulty. The brace, as will be seen, works at an angle of forty-five degrees to the bit, by means of a universal joint, and the pressure is applied directly through the arm, instead of through the sweep. It performs its work quickly, with a minimum expenditure of labor, and, owing to the straight arm just mentioned, can be used with advantage in the clear, as an ordinary brace. The tool is made by C. H. Amidon, 1451 Niagara street, Buffalo, N. Y.

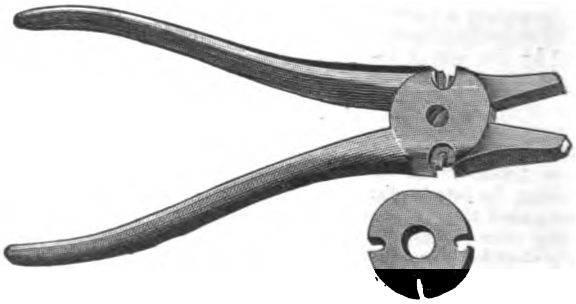


Amidon Corner Brace.

THE ACME PLIER.

The importance of serviceable pliers for linemen and others engaged in electrical construction has resulted in the expenditure of considerable ingenuity upon improvements in these very necessary implements.

The accompanying illustration shows the Acme plier and wire cutter, manufactured by the Higganum Hardware Co., of Higganum, Ct. The leading feature of these pliers consists in the fact that the cutters are interchangeable, so that when one wears out, or becomes dull, it may be replaced at a trifling expense, obviating the necessity of purchasing a new pair of pliers. The substitution of fresh cutters can be effected with ease and at a trifling expense.



The Acme Plier.

Concord, N. H.—The Concord Horse Railroad Company at its annual meeting elected the following directors: Moses Humphrey, Howard A. Dodge, Paul R. Holden, George A. Cummings, John H. Albin, Dexter Richards, George W. Abbott.

THE WILLIAMS SWITCH BOARD.

In The Electrical Engineer of June 11, 1890, appeared a sketch of the life of Mr. Charles Williams, Jr., whose untiring perseverance did so much toward perfecting the telephone, and whose switch boards, as early as 1877, and for nearly ten years after that date, were used by most of the telephone stations in the country.

The accompanying illustrations show two styles of the Williams switch board, which have remained standards for excellence and utility, and are still in service all over New England, as well as in other states.

The switch board shown in Fig. 1 is a cord board, with annunciator drops and automatic switches and keys for calling and connecting the telephone to subscribers' circuits. In this board the movements necessary to connect and disconnect subscribers are reduced to a minimum, and it is believed to be the simplest and most expeditious in manipulation of any board yet devised. It is in practical operation in about half the exchanges in the United States, and is the standard board adopted in Europe as well as in America for small exchanges. The board shown is for 50 lines and is 16½ inches wide, 18 inches deep, and stands 62 inches from the floor.

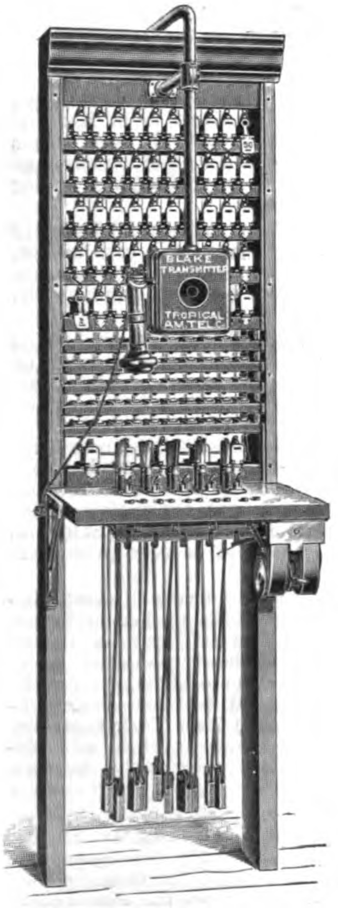


Fig. 1.—The Williams Cord Switch Board.

The peg board, Fig. 2, is arranged for table operators, and has met with great favor where there are only 300 or 400 subscribers in the system. These boards are lettered 1A, 2B, 3C, etc., and can be placed side by side, connecting each table with the next. They are 61 inches high on their stands, 37 inches wide, and 27 inches deep from front to rear.

The drop used in these boards is the Hynes or Williams drop, the use of which is controlled by the Tropical American Telephone Co., of Boston, Mass.

AN ELECTRIC LIGHT ON WHEELS.

Manager Charles Atkins, of the Council Bluffs Telephone Exchange, has invented a novel means of distributing incandescent electric light in various parts of his office. His invention was created by the necessity of having a strong light for examining the delicate points of the switch board, and consists of a portable car that travels on two copper wires that are strung the full length of the room about four inches from the ceiling, and just back of the switch board. Both wires are connected through a fuse box with the main incandescent circuit. The car is a small wooden affair with four metallic wheels, two of which rest on each wire. A flexible cord, having two electric conductors, passes up through the centre of the car, and each of the conductors is soldered to the frame. The lamp socket is attached to the other end of the double cord in the usual manner. With this arrangement the car can be run along the wires with ease, carrying the light wherever needed.

BALL ENGINES IN PHILADELPHIA.

Two 100 horse-power tandem compound engines manufactured by the Ball Engine Company, of Erie, Pennsylvania, are furnishing power for the new station of the Columbia avenue Electric Light Company, located on Columbia avenue, Philadelphia. Mr. J. W. Parker, agent of the Ball Engine Company, placed these engines.

WALL SOCKETS IN THE WEST.

That the Western people are appreciating the advantages of electric lighting more and more is shown by the steadily growing percentage of the electric trade which comes to Eastern houses from the West. As this Western trade is often most quickly and satisfactorily handled from a point near the Mississippi, many firms have established Western agencies. Hence the Bryant Electric Co. is having its switches and sockets pushed in the West by George Cutter, the well-known electric specialty dealer, of Chicago. As soon as the company found that their new sockets were proven by practical tests to be at least the equal of any on the market, they started to make wall sockets on the same plan. These were mounted on such neat wood or porcelain bases and so well made throughout that they made even a greater hit than the regular key socket. As the result, Mr. George Cutter has been getting orders for them faster than they could be made, and he expects to sell many thousands of them this spring.

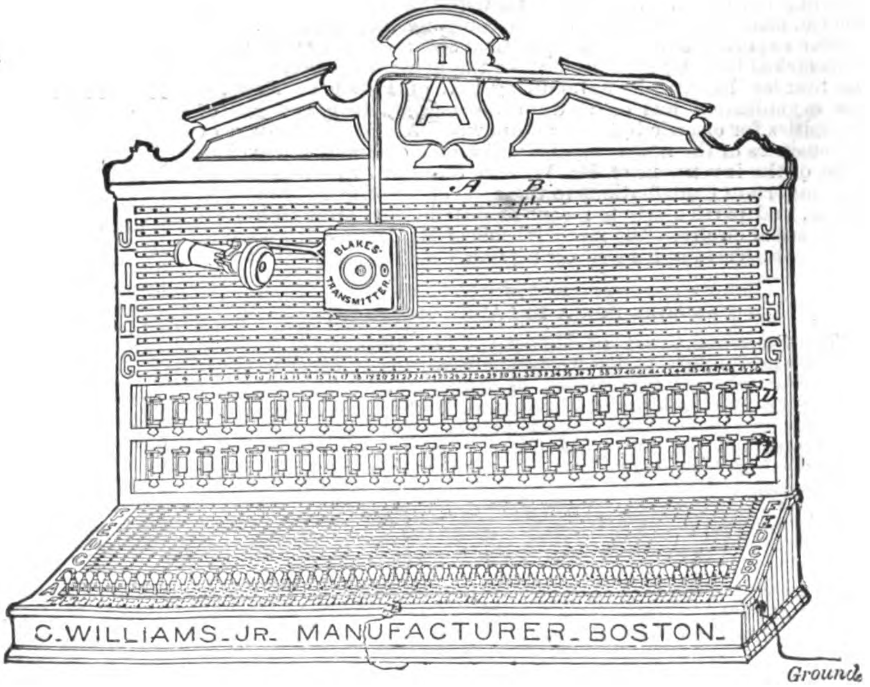


Fig. 2.—The Williams Peg Switch Board.

Mr. James Gamble is a pioneer electrician on the Pacific Slope. He is now busily engaged in electric railroading, and has fought the battle of the trolley very successfully in the newspapers. The fact that he is so active in electric railway work derives emphasis from his association with cable work, as he was at one time president of the National Cable Co.

Schenectady, N. Y.—Mr. J. H. Delany, of the Edison Machine Works, and son of Mr. P. B. Delany, the inventor, was married recently to Miss May Macdonald, daughter of Dr. George Macdonald, of Schenectady.

"K. K.' WIRE AND THE STORM.

The following is an extract from a letter received from The Bristol Electric Light and Power Co., Bristol, Pa., January 29th, 1891:

MESSRS. HOLMES, BOOTH & HAYDENS.
NEW YORK.

Gentlemen: All our K. K. lines withstood the storm of Saturday night. In two instances telephone wires rested across the mains without short circuiting us, and a number of such wires depended from our lines to the ground, without showing any ground at the station.

In fact, we have never had a break or ground on your wire, and hope that we never may.

Very truly yours,
[Signed] CHAS. E. SCOTT, Treas.

"HERCULES" TROLLEY WIRE.

The Electrical Supply Co., Chicago, report an increasing demand for Hercules trolley wire. This wire is specially drawn for electric railway work, and has in an unusual degree the particular qualities necessary to a satisfactory trolley wire. The company's facilities for furnishing it in any quantity are unexcelled, and the excellence of the wire is a recognized fact.

MR. HENRY HINE.—A NEW ENTERPRISE.

Mr. Henry Hine, district agent of the Westinghouse Electric Co., at New York, has resigned, to take effect February 15. Mr. Hine, who has been connected with the United States Electric Lighting Co. from its inception, and with the Westinghouse Electric Co. since its lease of the former company, and has had an extensive experience in both the practical and the commercial fields of electrical industry, will undertake the general managership of the Stanley Electric Manufacturing Co., of Pittsfield, Mass., a new organization just effected for the manufacture and sale of specialties for electric lighting and power. A principal feature of the business of the new company will be the commercial development of the inventions of Mr. William Stanley, Jr., whose useful and important contributions to the arts of electric lighting and power, and particularly to means of distribution, are well known in electrical circles. The many friends of Mr. Hine will wish him abundant success in his new connection.

DAMAGES FOR A DELAYED MESSAGE.

The Supreme Court of Mississippi has affirmed a decision against the Western Union Telegraph Company in favor of C. H. Alexander whereby he receives, as damages and interest, $2,500.

In 1886 Alexander sent a telegram to real estate dealers in Chattanooga to purchase certain property for him. The telegram was delayed thirty-six hours, and when delivered the property had been sold. Alexander then brought suit against the company. The company gained the case twice in the Circuit Court.

NEW ENGLAND TRADE NOTES.

THE CORLISS STEAM ENGINE CO., of Providence, R. I., are at present engaged in installing a compound condensing engine in the station of the United Electric Light Co., at Springfield, Mass. The cylinders are 22 inch and 44 inch by 5 feet stroke, and the pulley is 25 feet in diameter by 66 inch face, and weighs about 66,000 pounds. This is the second engine installed by the Corliss Engine Co. for the United Electric Light Co. There is undoubtedly a large and growing demand for high class compound Corliss engines, and judging by a visit to the factory of the Corlis's Co., at Providence, this company appears to be getting its share of the work.

NIGHTINGALE AND CHILDS, of Boston, report a very large and increasing demand for their magnesia covering, both for steam pipes in electric light stations, and for covering the cylinders and pipe connections of steam engines for electric purposes. Among their recent orders are the following: Covering for steam piping for the Ames Building in Boston; the Walworth Light and Power Co., Boston; New Bedford Gas Light Co., New Bedford, Mass; Worcester Electric Light Co., Worcester, Mass; Nashua Light, Heat and Power Co., Nashua, N. H.; Pittsfield Electric Light Co., Pittsfield, Mass; Lynn Gas and Electric Co., Lynn, Mass; Edison Electric Illuminating Co., of Boston; United Electric Light Co., Springfield, Mass., and several orders from the Thomson-Houston Electric Co., of Boston. The Corliss Steam Engine Co., of Providence, use large quantities of magnesia for covering the cylinders, heaters and connections of their engines, and other engine companies are rapidly adopting it.

THE JOHN BECKER MANUFACTURING CO., of Boston, are having a large sale at present of their name plates used for putting on engines, dynamos, motors and all kinds of machinery. This company are peculiarly well adapted for manufacturing these light castings, and have earned quite an enviable reputation for themselves on the attractive appearance of their goods. Mr. Becker has also made quite a success of his new vertical miller, and is filling orders for them as fast as he can manufacture them.

MR. STEPHEN E. BARTON, president of the Electric Mutual Insurance Co., of Boston, is about completing an arrangement with the American Casualty Insurance and Security Co., of Baltimore, Md., whereby he is prepared to issue insurance to all owners of electric light, power and railway plants covering all damage to property or person (whether employees or others) by reason of explosion of boilers; also any injury to employees or others from electrical or other accidents anywhere in the station or outside circuits; in fact to cover the liability of any electrical company for accident or injury to any person or animal.

Very unique and improved forms of policies, much more liberal, it is claimed, than any heretofore issued, are being offered by this company. Mr. Barton also issues policies in large stock companies, which he represents, covering all classes of electrical property while in transit from factories and work-shops to any part of the United States or British Provinces, and during the installation of plants, either central or isolated.

WESTERN TRADE NOTES.

MR. THOS. J. CREAGHEAD, formerly of the Westinghouse Co., of Chicago, is now doing an extensive business from his new offices, 37 and 38 Mitchell building, Cincinnati, O., where he is paying attention to consulting and constructing electrical engineering work. He is one of those brainy, hustling young electricians who always command success.

MR. G. A. EDWARD KOHLER, the Western representative of The Eddy Electric Motor Company, has, during the past month, sold 26 horse-power of machines of various sizes. Such a trade as this speaks strongly for the merits of the motor and for Mr. Kohler's abilities in securing business.

THE CHAS. MUNSON BELTING CO., of Chicago, have presented their many friends and patrons with a handsomely gotten-up calendar. The upper half is taken up with a very excellent colored engraving of some mammoth belts in progress of manufactures showing the machinery used, which is of special design and is one of the important factors that render these belts so excellent. In the right hand corner is their well-known Eagle trade-mark, and beneath are the letters O. K., which all who have used this belting say is eminently right and proper as expressive of the excellence of the belts. The lower half is devoted to the calendar, which is printed in handsome, bold type and is very prominent and striking.

THE WESTERN ELECTRIC CO. have issued a new and most comprehensive catalogue of their annunciators, bells, pushes, and other house goods. It is very handsomely illustrated, with a concise and clear description of each article, and should be in the hands of all who handle supplies of this kind. Some striking novelties in alarm clocks, etc., are contained in it, and the back cover is devoted to illustrations of their Chicago and New York factories, stupendous in their size and completeness, to say nothing of architectural elegance, and showing the vast character of the business handled by the Western Electric Co. and the enormous growth of the electrical industry.

MR. WM. H. MCKINLOCK, president of the Central Electric Company, met with quite a painful accident a few days ago, which confined him to his room several days. In running for a train he stumbled and was thrown headlong into the street; but, fortunately, escaped anything more serious than a sprained ankle. We are happy to be able to say that Mr. McKinlock has so far recovered as to resume his duties, though he still "favors" that ankle.

THE HAWKEYE ELECTRIC MFG. CO., of Davenport, Ia., manufacturers of the Thone system of arc and incandescent lighting, are preparing to place upon the market some new lines of apparatus of very high commercial efficiency and first-class workmanship. Their factory is pushed to its fullest capacity.

THE DAVENPORT FOUNDRY AND MACHINE CO., of Davenport, Ia., are about to largely increase their facilities for the manufacture of the well known Meyer engines, which are noted for their close regulation, high economy and small cost for repairs. Mr. Meyer has recently brought out an improved governor which gives the most satisfactory results.

MR. A. H. ZENNER, of Omaha, Neb., is now a special agent for the Electrical Supply Co., Chicago, looking after the sale of their goods in Iowa, Neb., Kan., and So. Dak.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. FEBRUARY 18, 1891. No. 146.

ELECTRICAL ENGINEERING AT COLUMBIA COLLEGE, NEW YORK.

ONE of the most interesting and striking features of modern educational work is the extent to which science has succeeded in winning a place for itself in every programme and curriculum. In fact, there is to be heard occasionally and in some quarters the assertion that at more than one seat of learning science has become the chief and favored study, so that the rightful claims of the older branches are overlooked and neglected in the desire to gratify the craving for physical research and for instruction in the great modern engineering professions. Perhaps this is true, but it is not to be denied that in thus shaping their aims and plans, our colleges and universities are but responsive to an urgent, insistent demand for teaching of this character—a demand that is none the weaker because it has long been disregarded and hushed down where it should first have met with a kindly and sympathetic response. It certainly cannot but be a cause of rejoicing to all concerned in the promotion of the arts and sciences that the day has at last arrived when the genius of the engineer is free to find its training and its career, no matter what the peculiar bent or enthusiasm may be.

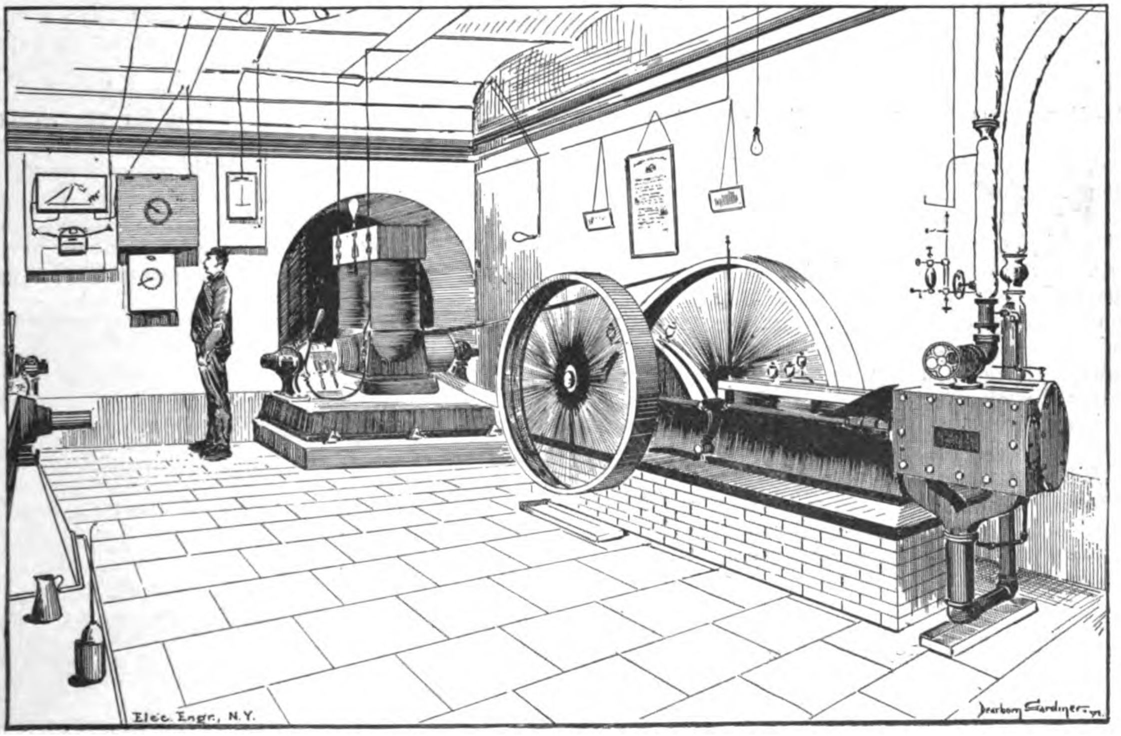


FIG. 1.—THE DYNAMO ROOM, COLUMBIA COLLEGE, N. Y.

As might have been expected, from its traditions, Columbia College was early impressed with the desirability of promoting scientific research on one hand and engineering on the other; and in due course its officers found themselves debating the propriety of so great an innovation as a course in electrical engineering The decision, arrived at promptly but without precipitancy, was that which might have been expected; and two years ago such a course was incorporated in the system of instruction and the degree of electrical engineer was added to the more familiar ones that the college grants.

Surely, if anywhere, there is encouragement in New York for the electrical student. The city is a centre for electrical enterprise and manufacture, and within its limits exist electrical installations unsurpassed in size, importance and value. Here, if anywhere, the latest electrical practice may be seen and criticised, and here, too, every new theory or investigation reports itself for approval or condemnation. The loss that the student may suffer through the varying distractions of a great city is more than compensated for in the stimulus he derives from actual contact with the throbbing realities of the profession he is soon to adopt. We need not wonder that the electrical course at Columbia has already proved a great success, and that the facilities offered draw hither aspiring youth anxious to acquire the engineering principles of the new art.

The plan resorted to by the government of the college was to establish a post-graduate course, the idea being that an undergraduate course, with numerous, untrained students, would require much space and many instructors. The post-graduate course implies necessarily a comparatively smaller number of students, and the entire absence of elementary instruction and disciplinary supervision. The course as established with this conception of its aim, covers two full years, and the requirements for admission to it are such that all preparatory studies, such as mathematics, physics, chemistry, mechanics, languages and drawing, necessary for grasping advantageously the whole subject of electricity, have been gone through. Experience shows that a student well grounded in these is the best qualified to make rapid and substantial progress in electrical work, whereas one lacking in the elements of preparation inflicts a two-fold loss, namely, on himself and on his preceptor.

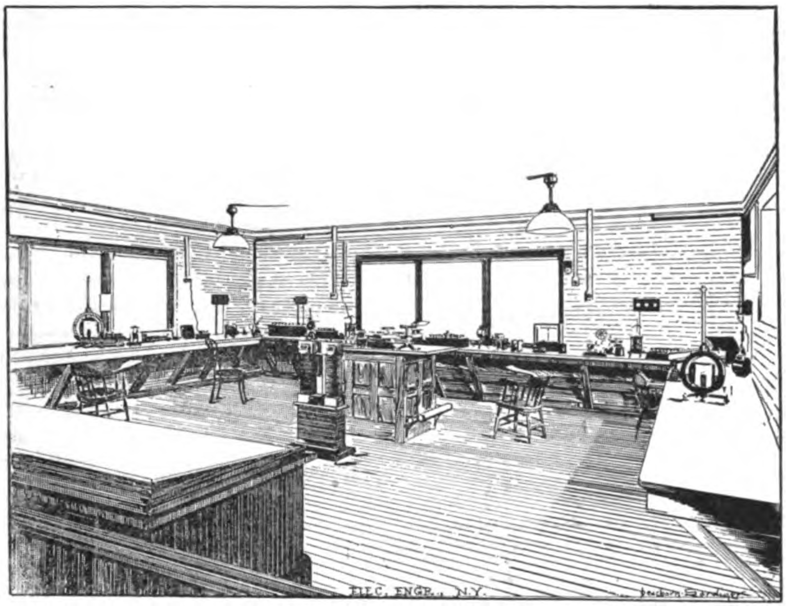

ELEC. ENGR., N.Y.

FIG. 2.—ELECTRICAL LABORATORY, COLUMBIA COLLEGE, N. Y.

The course, then, is almost entirely electrical, the more special reasons for this being stated by Prof. Crocker himself in the short article on the subject appearing in this issue. Such subjects, however, as mechanical engineering, and drawing, as applied to electricity, are included, as a necessary part of electrical engineering. The subject of electricity is taken up from the very beginning, with the assumption that the student knows nothing about it; and it would often be better if such were the case, nothing being more prejudicial to the acquisition of true knowledge than well-grounded misinformation. The instruction is carried along on three parallel lines. The first relates to the scientific and theoretical principles upon which the practical applications are based. The second deals with applied electricity, covering the practical facts, the apparatus and the "systems" used in and constituting the electrical art and work of the day. These first two lines are covered by lectures and recitations, the standard text books being used as far as possible as a basis only, it being the fact in electricity more perhaps than in any other branch, that the books are wanting in the fresh, vital examples which the instructor must suppply in order to complete the course and to give it character, meaning and utility. The third parallel line consists in practical laboratory work in electrical measurements of all kinds, and in workshop practice, as well as the testing of dynamos, motors, lamps and other electrical apparatus of all kinds. These three parallel lines of study are meant to advance, *pari passu*, so that at every stage theory and practice explain each other, and the principles enunciated are illustrated and driven home by the actual handling of the apparatus itself.

In addition to the regular examinations at the end of each term covering the term's work, a final examination is held that necessarily embraces the work of the whole period of two years. If it is passed satisfactorily, and a creditable graduation thesis is presented, the student receives the degree of Electrical Engineer, which is fully equal in rank and significance to that of Civil Engineer.

In starting the course, the College provided, and has since added thereto, a generous equipment of apparatus, inclusive of testing instruments of almost every kind. As far as possible these instruments are different, duplication being avoided, and preference has been given to instruments of American manufacture, or those most used in American plants and stations. This laboratory is shown in Fig. 2.

In Fig. 1 is shown the College electric lighting plant, consisting of two Edison 500-light incandescent dynamos, driven by a Straight Line engine and an Armington & Sims, each of 50 h. p. By special order of President Low, this plant is under the care of Prof. Crocker, and, of course, is very useful as a working example of an isolated plant, while the widespread system of distribution ramifying from it makes it in many respects a good type of central station. There are underground circuits connecting various buildings and the system of wiring is quite elaborate. The lights can be run on the Edison 3-wire system from the street, a switch being provided for that connection, and, when transferred to the College plant they run on the 2-wire system. The College plant is in daily operation from 7 a. m. to 10 p. m., and the Edison street circuit is depended upon during the other hours.

Besides this plant, a complete electric light and power plant is provided for the exclusive use of the students. It is shown in Fig. 3. It consists of a 25 h. p. McIntosh & Seymour engine, a 200-light Standard Electric dynamo, and a 4-light Thomson-Houston arc machine, with a complete set of lamps, switches, &c., of all the various makes. An Eickemeyer motor of 5 h. p. is used for running small dynamos and other apparatus for experimental work and is very convenient, being much simpler and handier for the purpose than starting a steam engine. Several 1 h. p. and smaller motors are used for running lathes, grindstone, &c.

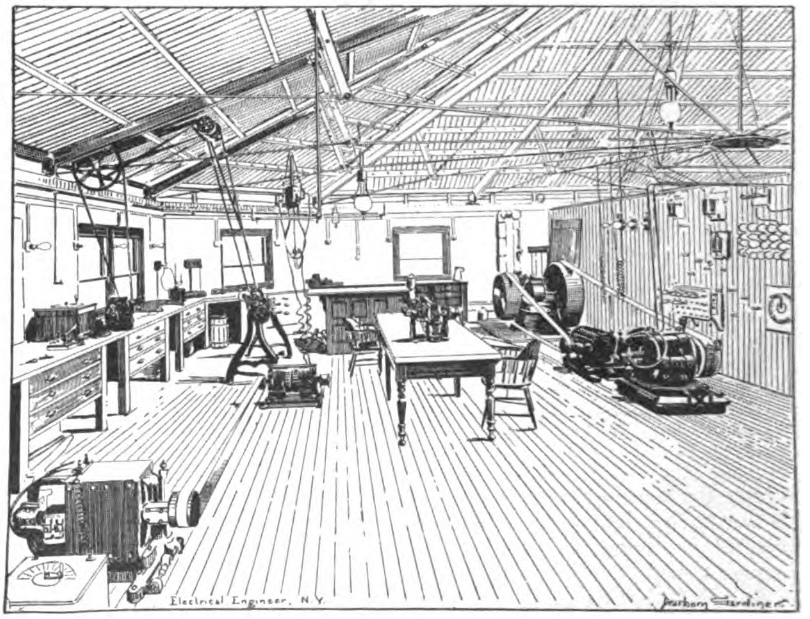

Electrical Engineer, N.Y.

FIG. 3.—ELECTRIC LIGHT AND POWER PLANT, FOR EXPERIMENTAL PURPOSES, COLUMBIA COLLEGE, N. Y.

Current, fortunately, is as abundant as water and just as freely on tap, for work at any time. At any point in the electrical laboratory, workshop, lecture room, &c., a current of 100 amperes and 115 volts can be drawn on immediately; and hence experiments of the heaviest nature can be made. One experiment was lately carried on that required current uninterruptedly for a whole week. Facilities of this kind are a great boon.

Reference might be made to many interesting features of the work done, but it will suffice to mention the 1,280-cell storage battery shown in Fig. 4. This was made by the students. The cells are of the Planté type, and are 1 inch diameter and 4 inches high, glass tubes being used. The battery is arranged in 40 rows of 32 each, with a switch for throwing them in series or in multiple. As will be seen, this compact little battery would give nearly 3,000 volts, if connected up throughout in straight series. The cells are set in paraffine, poured around them and solidified.

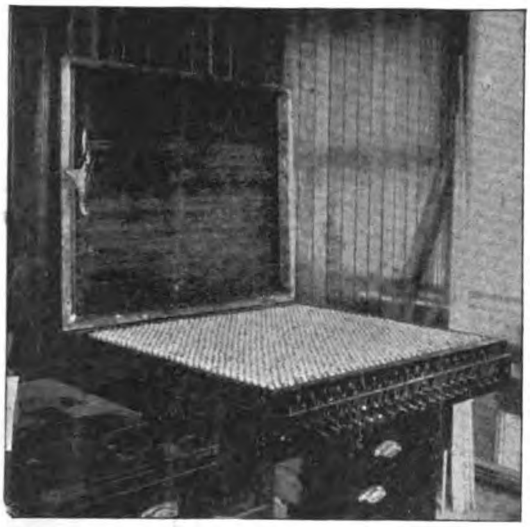


FIG. 4.—A 1280-CELL STORAGE BATTERY.

The course in electrical engineering, of which a description has been given above, is now in charge of Prof. Francis B. Crocker and Dr. M. I. Pupin, the former of whom is the instructor in electrical engineering proper, and the latter in its mathematical physics.

INFLUENCE OF THE SPARK ON RESISTANCE.

MR BRANLY has recently found that the spark of a Holtz machine or induction coil has a remarkable effect in temporarily decreasing the resistance of certain badly-conducting mixtures, such as powdered or oxidized metals, or pastes formed by immersing filings of iron, copper, or other metals in a non-conducting fluid. The effect is generally increased by connecting one or both of the sparking terminals with the substance under test, although the spark alone may be sufficient. In one case the resistance of a junction of two pieces of oxidized copper, as measured by a Wheatstone Bridge, was reduced from 80,000 ohms to 7 ohms in this way. The diminution of resistance of such conductors may last for as long as 24 hours, unless the substance is disturbed by vibrations, in which case the high resistance is restored.

AN ELECTRICAL DEVICE FOR DETERMINING THE ACCELERATION DUE TO GRAVITY.[1]

PROFESSOR F. R. BARRETT, B. A., recently exhibited a lecture room device for determining "*g*," the acceleration due to gravity, by means of a number of iron balls falling through a certain distance, one starting at the instant when its predecessor reaches its destination. This is accomplished by means of an electro-magnetic device in which the balls, falling on a key, make and break a circuit, each ball as it falls liberating the next. From the time occupied by all the balls, the time for one may be found. The apparatus is said to give fairly accurate results.

WHAT AN ELECTRICAL ENGINEER SHOULD BE.

BY

Francis B. Crocker

IT has often been stated on high authority, such as that of Sir William Thomson and Prof. W. E. Ayrton, that the electrical engineer should be largely a mechanical engineer, the proportions usually given being "nine-tenths mechanical and one-tenth electrical." This statement is frequently repeated and has been generally, if not universally accepted. The causes which have operated to produce this opinion are, first, the fact that the extraordinarily rapid development of electric light and power has prevented even reasonable care being given to the design and construction of electrical machinery, and second, the work has generally been in charge of men entirely ignorant and incompetent, or at best, of men who had received their preparation in telegraph offices or physical laboratories where strong mechanical construction is given comparatively little attention.

In the first stages of the development of any branch of industry, the men attracted to it are apt to be either amateurs, inexperienced boys, or worse yet, quacks or men who have been unsuccessful in other lines of work.

As soon, however, as sufficient time has elapsed for men to become well prepared by education or experience and the industry becomes legitimized and attracts to it a higher order of talent, then the necessary elements to give the best results will be present and a proper relation and balance will exist between them.

I consider that this now is, or very soon will be, the condition of electrical engineering, and I contend that the electrical engineer must be an *electrical specialist* and that mechanical engineering, though a necessary part of his preparation, is nevertheless merely incidental.

The simple, and what seems to me, a more than sufficient reason for this opinion is the fact that the purely electrical part of electrical engineering is being so very rapidly and extensively developed that no one person can possibly keep up thoroughly with electrical progress in its numerous branches even at the present day and no man busy in electrical work can spare the time to read even the more important electrical journals and books. In fact it now seems to be necessary for one to become a specialist in some particular branch of electrical work in order to be successful. Such being the case, it certainly is impossible for the general electrical engineer to give more than a small fraction, say one-quarter, of his time to mechanical engineering instead of the nine-tenths heretofore recommended. This is not because mechanical engineering is not of the greatest interest and importance in itself, but because a man's time and abilities are limited and *electricity* is a gigantic subject, a small part of which is probably all one human mind can master.

In order not to be misunderstood, I will state that I thoroughly realize that mechanical engineering is, and probably always will be, an essential *part* of the electrical engineer's knowledge, just as chemistry is essential to an understanding of electro-metallurgy, primary and secondary batteries, etc., but only as a preparation.

In any case the electrical engineer should be an *engineer* in the broadest and best sense, his profession being analogous to, but not identical with, that of the civil, mechanical, and mining engineers.

In conclusion, I would call attention to the fact that the mechanical weakness which arose in the early development of the dynamo and motor has now nearly passed away, and to-day the standard types of dynamo and motor are probably as well made mechanically as any other class of commercial apparatus. Moreover electrical machinery is usually remarkably simple, mechanically. Compare the number of working parts of a 50 h. p. motor with those of a corresponding steam engine and there will be found in the former about one-fifth as many oil cups, bearings, pivots, sliding surfaces, etc.

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[1] Proceedings of The Physical Society, London.

On the other hand what is needed in the dynamo and motor to-day is improvement in the armature, commutator and brushes, and in means for avoiding sparking, burning out, etc., all of which belong to the *electrical* part of the machine and involve very difficult electrical questions. Of course first-class mechanical construction is necessary even in these parts but only as incidental to the carrying out of correct electrical principles.

In the design of a street car electric motor, which is peculiarly mechanical, although the electrical difficulties encountered have been fully as great as the mechanical, I believe that a mechanical engineering specialist should be employed just as an architect should always be called in to design a house or a plumber to put in water pipes.

THE "CAMBRIDGE" ACCUMULATOR.

In all the storage batteries now generally in use, the principle employed is the suspension of the active material in some form of leaden grid. Various forms of grid are in use, but all use the lead as a means of support for the active material, as well as forming the electrodes of the battery.

In the battery recently invented by Mr. G. E. Hatch, of Cambridge, Mass., which we illustrate in the accompanying engravings, the lead is not employed for supporting the active material, but simply as an electrode, lead being the only known substance which can be successfully and commercially used as a conductor submerged in dilute sulphuric acid. The active material, as will be seen, is supported by a porous plate, and comes as near as possible to the ideal battery of this kind, having the active material in suspension in the solution without support.

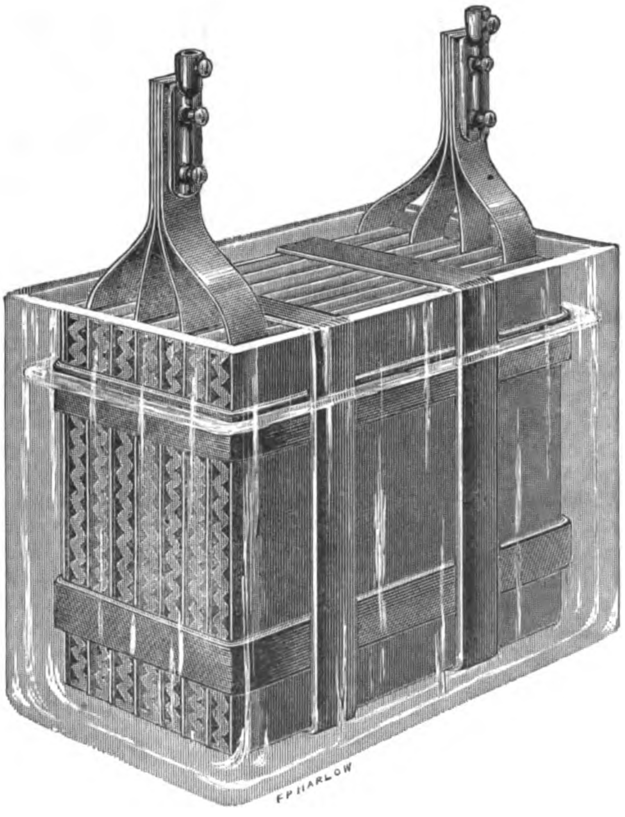


Fig. 1.—The Cambridge Storage Battery.

The fundamental principle of the Cambridge battery is a porous plate, shown distinctly in Fig. 2, which represents the battery set up before immersion. This porous plate is designed to have the greatest amount of porosity obtainable and is corrugated as shown. The active material is filled into the corrugations until quite flush and smooth, as shown by the dark black zig-zag spaces in the engraving, and the corrugated porous plate acts as a support for this material, instead of the leaden grids generally employed.

The porous plates for a 200 ampere-hour cell are each 7 inches square, ½ inch broad, and the corrugations are ¼ inch deep. It weighs, when dry, about 10 ounces, and when wet, about 15 ounces, and is thus capable of absorbing about 5 ounces of liquid. After the corrugations of the porous plate are filled with the active material, the lead conducting plate is placed alongside—the positive on one side and the negative on the other—with lugs extending upwards to the terminals. These plates are made of an alloy which is only very slightly affected by electrolytic action, and weighs about 2 pounds to the square foot.

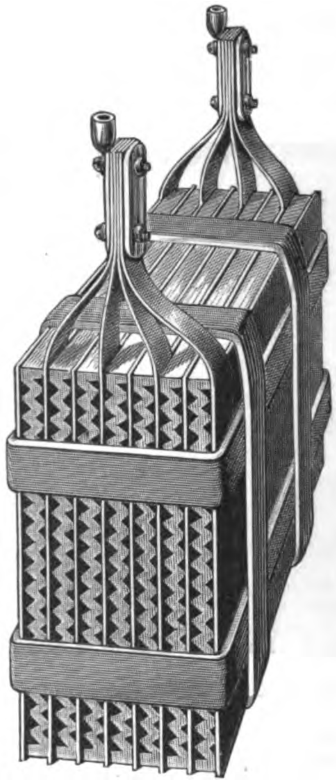


Fig. 2.—The Cambridge Storage Battery.

The 200 ampere-hour cell complete, consists of seven porous plates with the active material, and eight lead electrodes, and weighs, when dry, about 28 pounds, of which the lead electrodes weigh only 7 pounds. The whole cell complete, as shown in Fig. 1, with glass jar and liquid weighs about 35 pounds. The element consisting of the house plates, active material and lead electrodes stands 7 inches high, 7 inches deep and 4¾ inches wide, and compared with cells now in use, is claimed to have double the capacity for the same size and weight.

Among the advantages claimed for this type of storage battery are first, that owing to the construction adopted, there is no possibility of buckling of the plates, no matter how heavy the charge or discharge, and therefore an entire absence of short circuiting. The absolute control of the active material is provided for by its being shut in so that it cannot be thrown out of its place by expansion or contraction, or by jolting, if used for car service. The cell is flexible, being bound together simply by rubber bands, which allow of expansion and contraction, which occurs when the cell heats up from heavy charge or discharge.

The battery requires very little care and can be discharged, even should the glass or rubber containing jar be broken, sufficient moisture being retained in the porous plate to totally discharge the cell. The writer himself saw a number of lights actually burning, with one of the elements of the series of cells outside of any jar containing liquid, without the slightest diminution of the brilliancy of the light. The gases which are generated by electrolytic action are freed as in other cells, owing to the extreme porosity of the porous plates.

The Cambridge Accumulator, we may add, is now being introduced by the Cambridge Accumlator Co., of Boston, Mass.

THE PROPOSED ADAMS ELEVATED ELECTRIC RAILWAY SYSTEM IN CHICAGO.

Like all cities whose population is spread over a wide area, Chicago has for a long time experienced the want of a rapid transit system. It is true that it possesses even now a system of cable and horse cars probably not inferior to that of any other city of equal size, but the speed obtainable with these, even under the best conditions, does not satisfy the wants of the large majority who live at a distance from their place of occupation, and those also whose business requires a quick method of reaching the various parts of the city.

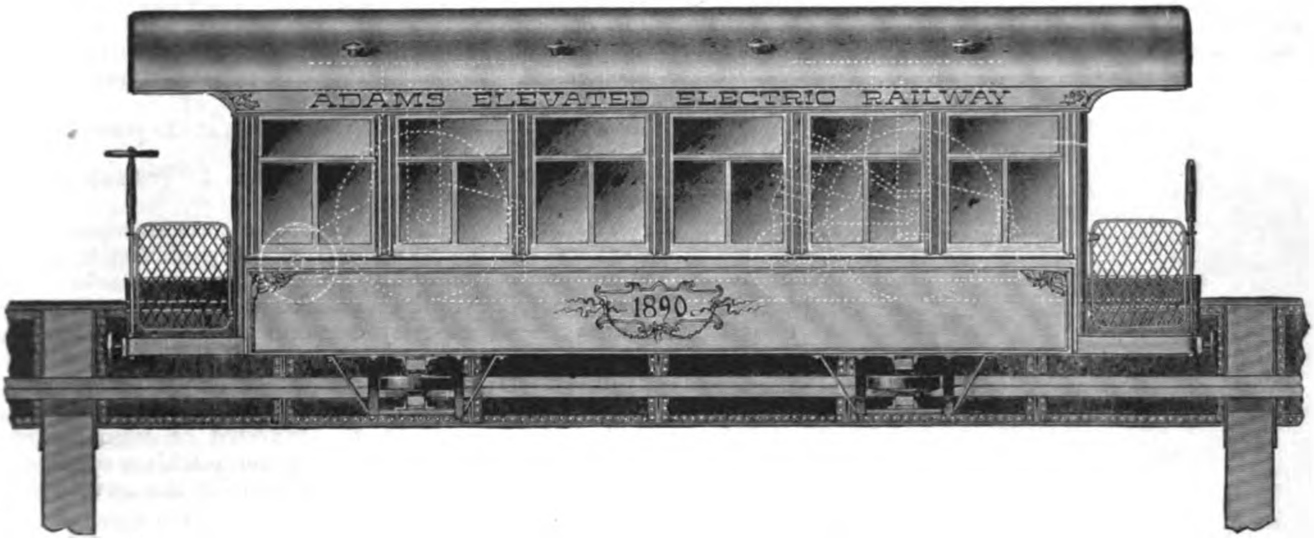


Fig. 1.—The Adams Elevated Electric Railway.—Side Elevation.

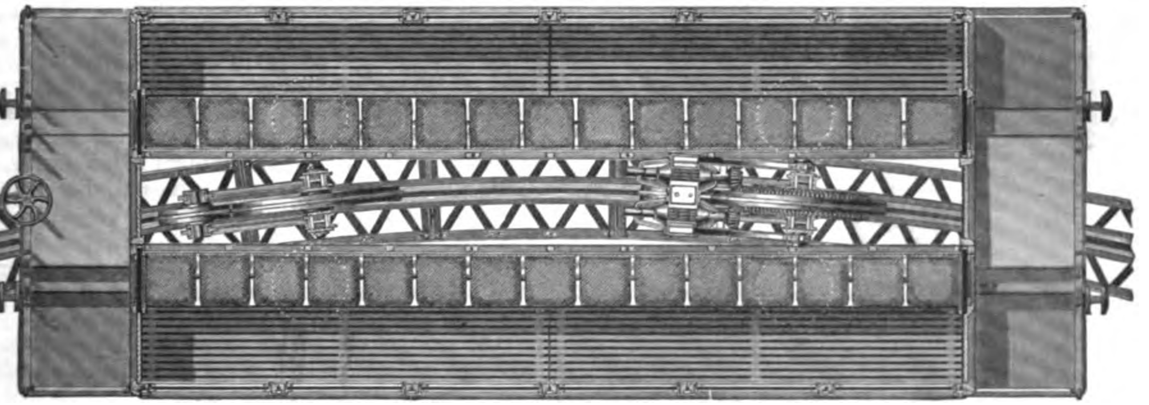


Fig. 3.—The Adams Elevated Electric Railway.—Plan View.

It is obvious that to obtain the desired speed some other method than the surface railway must be adopted, and with the great cost of an underground railway to be contended with, an elevated road is held to be at present the only solution of the problem.

Among those who have been prominent in agitating such a system for the city of Chicago is Mr. J. W. Adams, who has devoted a large share of his attention to the subject, and has elaborated a plan of construction and operation for such a road which cannot fail to attract the attention of electrical engineers.

The plan proposed by the Adams Company contemplates the erection of a single track, single column elevated railway, so as to present as little obstruction as possible to traffic and light in the streets, and the operation of the road by electricity, thus at once removing one of the principal objections to the elevated railway.

It is designed to effect the rapid and effective handling of passengers by frequent and rapidly moving single cars, and by confining entrance and exit to the opposite sides of the rear platform in charge of a gate man. The use of the single car instead of a train allows of a great reduction in time required in starting from rest to full speed, as well as in stopping at stations, so that an average speed of 20 miles per hour is confidently looked for as practical in this system.

The cars will be operated continuously in the same direction on a loop 20 miles in length, and at a distance apart of 750 feet, which is equivalent to a headway of 20½ seconds; this is considered perfectly practicable with single car units, and with the special track brakes to be employed, so that 140 cars would be in continuous operation on the circle.

The proposed construction of the elevated structure and the cars will be readily understood from the accompanying engravings.

The columns supporting the superstructure are about 14 feet in height in the clear, and set 40 feet apart, and their dimensions are 15x18 inches; they are set in concrete about 8 feet deep in the ground. The girders forming the superstruction are 3′ 8″ in height by 2′ 6″ in extreme width. The strength of the whole structure is such as to sustain a moving load of 20 tons per car including dead and live loads, and 25 per cent. added to the strains derived from the above stated loads, the sections of the main girders being proportioned accordingly. This construction has been figured on the basis of carrying a maximum capacity of 279,000 passengers per day. Each car will be provided with two 4′ 6″ drive wheels, each of which is rigidly connected to a 2 foot pilot wheel, all being made of paper. These two wheels are supported, and both swivel on the same turn-table, and adapt themselves not only to the curves, but to the slightest irregularities of the track, making the movement of the car very easy. The rail employed is of special design, having the tongue space in the centre and is rolled for this purpose, and the wheel is constructed with the flange in the centre.

Our readers will, of course, be particularly interested in the electrical arrangements to be adopted. These have been under consideration for some time by Mr. Frank B. Rae, the electrician and engineer of the Detroit Electrical Works, who has been retained as consulting electrical engineer to the road.

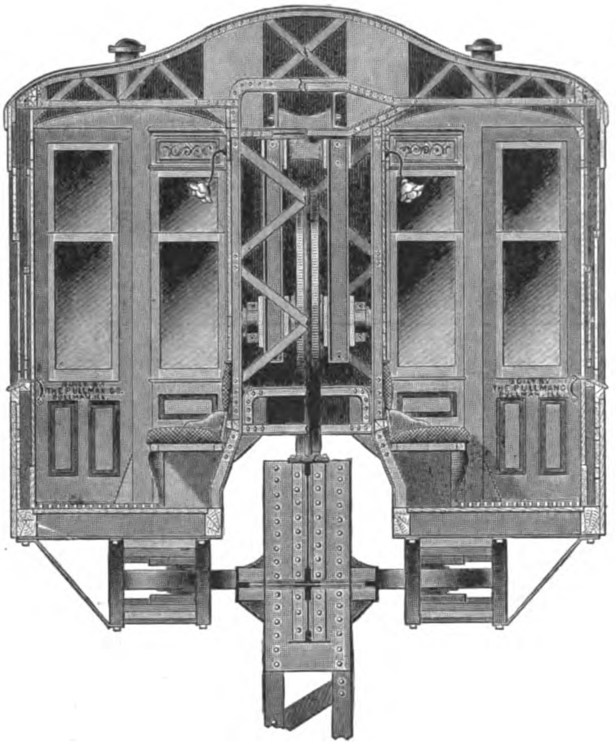


FIG. 2.—THE ADAMS ELEVATED ELECTRIC RAILWAY.—SECTIONAL VIEW.

It is proposed to equip the cars with a double field motor having two armatures and gearing, by bevelled pinion, directly to the large wheel of the truck, as shown in the plan, Fig. 3. By this construction, the power is applied equally to both sides of the wheel and end thrust upon the bearings is entirely eliminated. The electrical horse power of the motor will be normally 50 h. p., the motor being designed to develop for a short time at least 75 h. p. The ratio of reduction by the gearing will be 9 to 1 and the maximum velocity of the armatures at a car speed of 25 miles per hour will be 1,400 revolutions per minute. By the use of leatheroid and raw hide pinions upon the motor shafts and by the use of paper wheels, the noise will be reduced to a minimum.

In considering a system of 20 miles of track, the maximum number of cars that can be operated practically is determined largely by the number of stops that will be made by each car, for the reason that the time required to raise the car from its position of rest to full speed depends upon the power available to overcome inertia and this is limited to the capacity of the motor. The weight of the loaded car is taken at 20 tons and the extreme maximum power of the motor for a few seconds, when it is just reaching the maximum speed of 25 miles per hour, is 70 h. p.

In the determination of the copper required to supply power as above to 212 cars, on a basis of 1 stop in 3, it is thought that the maximum draught cannot exceed that required by two-thirds the total number of cars, each taking the average number of horse-power which is required to raise it to a speed of 25 miles per hour from rest, so that the maximum horse-power equals $\frac{2}{3} \times 212 \times 36$, or, 5088 at the wheel axle. Allowing 80 per cent. efficiency in gearing, 80 per cent. efficiency of motors and 90 per cent. in conductors, this figure becomes 8,833 electrical h. p. delivered to feeders. This would call for a weight of 2,253,450 lbs. of copper, in order that the loss shall not exceed 10 per cent. This loss is deemed both practical and economical. Reducing this copper to cost per mile, we have $\frac{2,253,460}{20} = 112,673$ lbs., which at the present market price of 19.75 cents per lb. amounts to $22,243 per mile, exclusive of erection.

The station electrical equipment would consist of 20 dynamo machines, having a capacity of 500 h. p. each, aggregating 10,000 h. p., and driven in banks of five machines from triple expansion engines of 2,500 h. p. each, with a reserve capacity of 10 to 20 per cent. above this. Each of the dynamo machines would be connected to the engines through a countershaft and clutch pulleys and so arranged mechanically and electrically that any single unit of 500 h. p. might be connected or disconnected at will; thus the number of dynamo machines operated at any time may be only that required for the service at the time.

Each car is to be lighted with incandescent lamps as follows: 1 head light, 1 rear red light, 1 rear platform light, and 12 inside lights; total, 15 lamps. Total for 212 cars, 3,180 lamps.

Each station is designed to have 10 lamps. This would give, total for 10 stations, 1,050; cars, 3,180; total, 4,230 lamps. This would call upon the power plant for additional 425 h. p. when all are in use, taking on an average 10 lights per mechanical horse-power.

As indicated above, the engines to be employed would be of 2,500 h. p. of the compound condensing type, consuming, say, 3 lbs. of low grade coal per horse-power per hour. The station is to be situated near water, so that no cost will be entailed for water. The price of slack coat at Chicago is about $2.00 per ton, delivered.

The central station expenses per day of 18 hours, with an average load 8,000 h. p. are assumed to be as follows:

Coal	$432.00
3 engineers at $4.00	12.00
3 engineers at $3.00	9.00
4 firemen at $2.00	8.00
2 electricians at $4.00	8.00
2 asst. electricians at $3.00	6.00
Oil, waste, etc	10.00
Total	$485.00

It will, of course, be understood that these electrical estimates are merely preliminary in their nature and will no doubt be subject to more or less modification when the details to be adopted are thoroughly worked out. The project is certainly a feasible one and it is to be hoped that Chicago will afford the opportunity of demonstrating the undoubted economy which can be effected by electric traction.

THE RIKER SLOW SPEED BIPOLAR MOTOR.

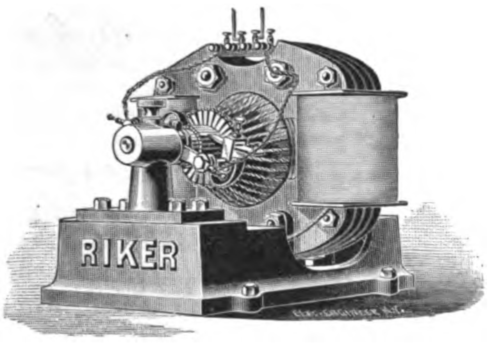
BY

Andrew L. Riker.

Most low speed motors manufactured are of 5 h. p. or upwards, because of the loss of efficiency in small low speed bipolar machines or of the impracticability in winding a multipolar machine of small horse power.

After a considerable time spent in experimenting and testing, the writer has succeeded in producing a bipolar slow speed machine at moderate cost and of high efficiency.

By those thoroughly acquainted with the changes made in dynamo electric machines or motors, it will be remembered that the writer was one of the first to use a laminated field, and the first to use and continue in the use of a toothed armature. By a constant study of its peculiarities and a thorough acquaintance with its workings, during this time, in high speed machines, he has at last been enabled, by using it in connection with a special winding of his own design, to make a slow speed machine from ½ to 5 h. p. of very high efficiency and simplicity of construction, which is illustrated in the accompanying engraving.



The Riker Two-Pole Slow Speed Motor.

The machine has its field magnets built up of laminated iron bolted together and is fixed to the base by gun-metal brackets, so that no magnetic leakage occurs. The ½ h. p. machine illustrated is designed to run at 650 revolutions per minute, at which speed it develops an efficiency of over 70 per cent. The motor weighs less than 100 pounds and the shunt field takes about 30 watts to energize it, its resistance being 280 ohms. The writer proposes to make a series of tests on the machine, which will be duly reported.

THE MOSHER ARC LAMP FOR INCANDESCENT CIRCUITS.

One of the objections that has been raised against the arc lamp is the uncertainty of its action when used upon incandescent circuits, thereby entailing the employment of a separate circuit when a few arc lamps are used in conjunction with incandescent lights. Several forms of arc lamp, designed to meet this want, have been used in considerable quantities, being directly connected upon the incandescent mains with the intervention of a metallic resistance or incandescent lamps in series, to maintain steadiness in the arc lamp, and prevent flickering on the incandescent lamps, due to the feeding of the arc lamp carbons.

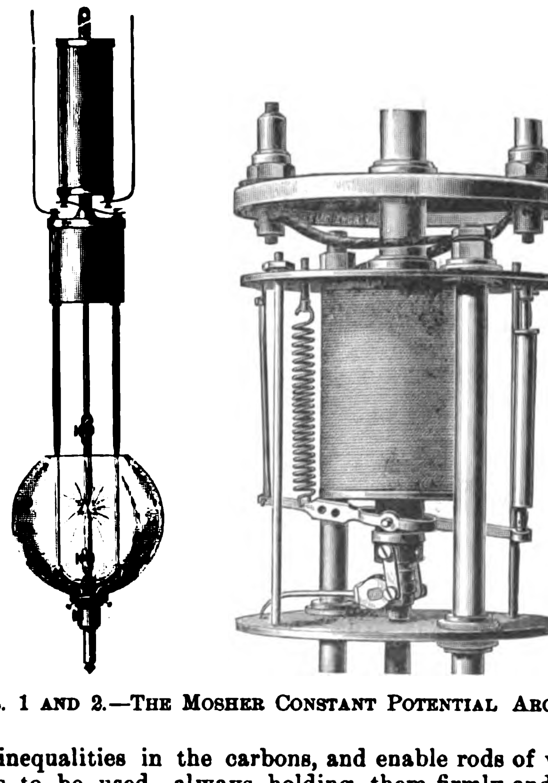
The latest lamp designed for this purpose is the Mosher arc lamp, for which are claimed important and highly advantageous improvements and modifications, and it is said to be giving satisfaction wherever introduced. The lamp is shown in Fig. 1 of the accompanying illustrations, and is of remarkably neat and simple design. It is made in brass, nickel or iron, and is adapted to burn either singly, or in series.

One of the novel features of this lamp is the employment of carbon resistance as the regulating factor. This is simple and capable of the most exact adjustment, and is one of the reasons that the lamps give such a perfectly steady light, and such excellent results in practice. The carbon resistance rods are arranged in series with the lamp, and, if desired, can be dispensed with, incandescent lamps being substituted. They are contained in a brass case placed above the working mechanism of the lamp, and perforated for ventilation.

The amount of current utilized is regulated by varying the resistance; the fewer carbons in the rheostat connected in circuit, the more current absorbed, and vice versa. The resistance is varied with the greatest facility by sliding one or more of the inner clamps surrounding the carbon rods upwards towards the upper porcelain disc, between which and a similar disc at the bottom, the carbon rods are supported. Each clamp moved from the lower to the upper disc cuts out two carbons. There are 39 carbons in the rheostat, which is adjusted to 110 volts and 4½ amperes. By cutting out five or six carbons, the current will be increased about two amperes.

The working mechanism of the lamp, shown in Fig. 2, consists of a solenoidal magnet with a hollow core, through which the upper carbon holder passes. The action of the current on the magnet operates a lever and clamping device. One end of the lever is furnished with a dash pot which can be filled with glycerine or oil, and at the other is a spring having at the top a screw, by means of which the length of the arc can be effectively and instantaneously regulated.

The carbon clamps at the ends of the rods are of novel and ingenious construction. They adjust themselves to all inequalities in the carbons, and enable rods of various sizes to be used, always holding them firmly and maintaining the points directly in line. The lower carbon holder is furnished with a ball joint attachment, which is regulated by means of a screw at the lower point of the lamp.



Figs. 1 and 2.—The Mosher Constant Potential Arc Lamp.

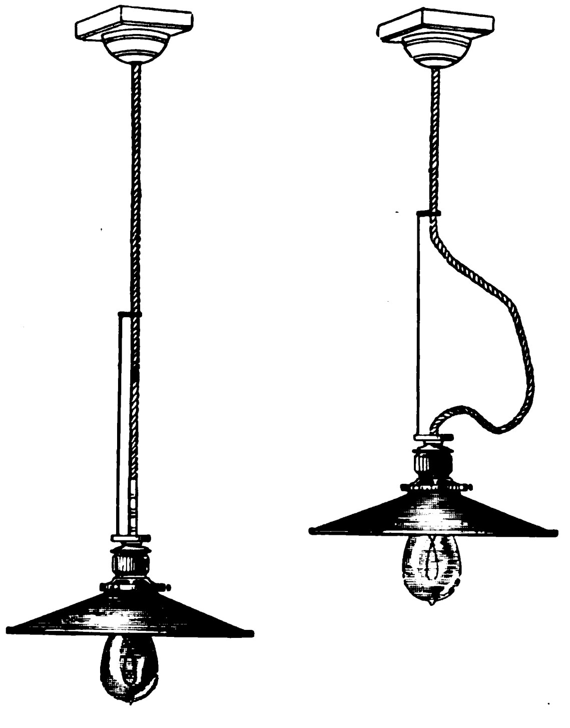
Recent tests made by high authorities have shown the lamp to work very smoothly with a silent arc and no flickering, giving a steady and brilliant light. The simplicity of the entire construction, the ease of adjustment, and the economical and perfect operation will, it is believed by the makers, at once commend this lamp to central station men, and all those who desire to use arc lamps upon incandescent circuits.

SCHENCK'S CORD ADJUSTER FOR SUSPENDED INCANDESCENT LAMPS.

The percentage of incandescent lamps broken has been found to be even greater than that due to failure on account of the exhaustion of the filament, and any device insuring safety in this particular is deserving of consideration.

Mr. Unico H. W. Schenck, the well-known inventor has invented a very simple and complete device to prevent breakage. It operates by raising the lamps to any desired height, when suspended from the ceiling by flexible cords, and is therefore particularly adapted to factories. It has been ascertained that numbers of lamps are broken in factories and machine shops, by flying clips; by the careless use of files, hammers, and other hand tools; and by pieces of iron, wood, etc., carried upon the shoulders of the men; and all because the lamps are not elevated beyond danger from such causes when not in use.

The device will be clearly understood by reference to the accompanying illustrations, where Figs. 1 and 2 show it in operation. It consists of a wire rod one end of which is rigidly attached to the lamp socket and the other fashioned into a goose-necked loop, shown in Fig. 3, through which the flexible cord passes.

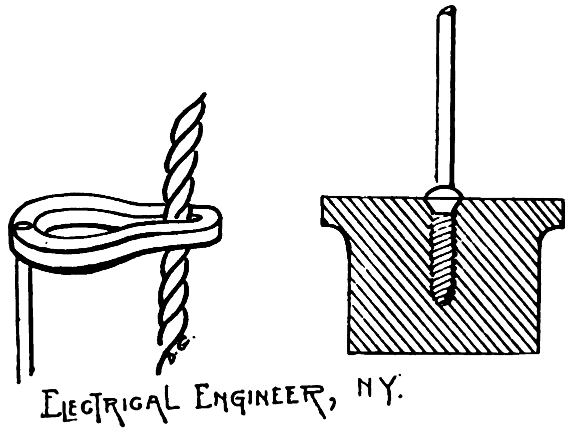


Figs. 1 and 2.—Schenck's Cord Adjuster For Pendant Lamps.

Where the lamp has a brass socket, as shown in Figs. 1 and 2, the rod is provided with a clamp at its lower end. When, however, a wooden socket is used, as in Fig. 4, the rod is simply screwed into the centre hole that is formed in the process of manufacture. Thus the device may be readily attached to the lamp without the use of screws or tools of any kind.

The raising of the lamp is effected by simply allowing the cord to run through the large end of the loop in the rod, and when the proper height is reached, catching it in the small end, which binds sufficiently to sustain the weight of the lamp.

It will be seen that this can be done with one hand. Such a device recommends itself for prompt and widespread introduction, and will do much to enhance the reputation of the incandescent lamp for durability and longevity.



Figs. 3 and 4.—Schenck's Cord Adjuster For Pendant Lamps.

LOCATING FAULTS IN UNDERGROUND CABLES.

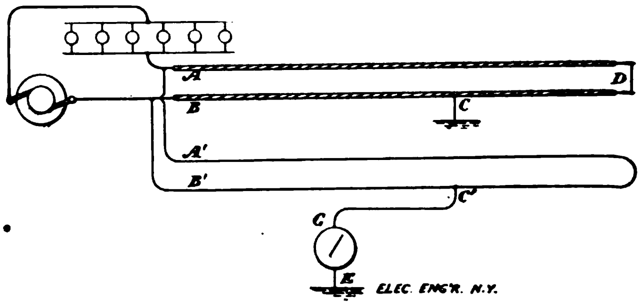
BY

R. J. Burt

Every central station manager knows how difficult it is to locate a fault or ground in an underground cable of large section and low resistance, especially when the resistance from one end of the cable to the fault is almost negligible in comparison with that of the fault. The following is a simple method used with great success by the writer in the Thomson-Houston central station of the "Electra" Compania General de Electricidad, in Bilbao, Spain. It adapts itself for locating faults more especially in feeders or simple lengths of cable without branches.

Supposing one of a set of cables, the plus, minus, or neutral, all of equal section, has a fault or ground, and one of the other two still remains perfect; then by joining the faulty cable to the good one at the further end, usually in a distributing box or junction box, a current can be sent through the cables, and we have in the station the two ends between which there is a considerable difference of potential due to the "drop" in the cables.

Now referring to the accompanying diagram, A and B are the two cables; A′ B′ is a german silver wire of about one millimetre section, calibrated to insure a uniform resistance, and of about one-tenth the length of the two cables. This resistance can be strung up across the dynamo or testing room several times and its terminals connected to the two cable ends..



A Simple "Ground" Test.

G is a sensitive astatic galvanometer with one pole to earth and the other connected to a long, well insulated wire, the end of which can be slid along the german silver wire.

Now, upon passing a strong current through the cables and sliding the wire along, the galvanometer needle will come to rest just as it does in the Wheatstone bridge, for it is the same principle upon a large scale. This point on the wire will correspond exactly with the position of the fault in the cable, for $B'C' : D'C' = BC : DC$.

Great care must be taken to insulate well the other pole of the dynamo. The sensitiveness can be increased by increasing the current. Nearly every station has its bank of lamps which can be used for this purpose.

THE STANDARD CROCKER-WHEELER MOTORS.

SOME years ago we published an article by Mr. T. D. Lockwood upon "The Cheap John" in electrical engineering, calling attention to the lamentable fact that many of the failures in early electrical work had been due to the use of the cheapest and most inferior construction, instead of such as would be permanent and adequate to do its duty in an easy and enduring manner. The author longed for the day when the industry should have passed out of this stage, and all electrical work should be done as thoroughly as other engineering work, without regard to a somewhat greater first cost.

Indications are not wanting to show that, happily, in more than one department, the improved and durable construction so much to be desired in electrical apparatus, is now being carried out. Among the apparatus in which excellence of manufacture is a prime necessity for continuous and satisfactory work, the electric motor undoubtedly occupies a foremost position; and it was with this point prominently before them that the Crocker-Wheeler Electric Motor Co., of this city, some time ago undertook the designing of, and have now completed, a series of standard electric motors, a description of which will indicate the lines upon which the improvement has been effected.

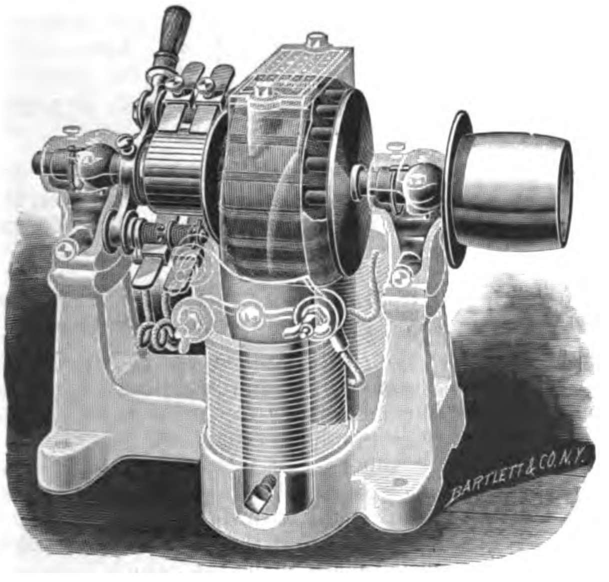

BARTLETT & CO. N.Y.

FIG. 1.—GENERAL TYPE OF CROCKER-WHEELER MOTOR, 1-6 to 1 H. P.

The general types of these motors is illustrated in the accompanying engravings, in which Fig. 1 represents the type employed in the sizes varying from $\frac{1}{6}$ to 1 horse power, and Fig. 2 the 5 horse power machine.

The field magnets are composed entirely of the best wrought iron, each magnet being forged in a single piece, and set deeply into the base, thereby securing great solidity and ample magnetic contact. The space for wire on the magnets is perfectly cylindrical in the form of an ordinary spool, thereby insuring smooth and perfect winding of the wire, and is short in length, permitting the shaft of the machine to be low enough to free it from vibration. By this construction the freedom of the base from magnetism is secured, and there is no tendency to leakage.

The armatures are sufficiently large in diameter to obtain slow speed, and are so designed that the wire winding is entirely embedded below the surface of the iron core, thus protecting it from all injury, holding it rigidly in position, and rendering it possible for the magnets to approach very closely to the core, so that an intense magnetic effect is produced. The armature is mounted upon a brass face-plate which is first turned perfectly true, and after completion the armature is very carefully balanced, so that when run at full speed the motion is hardly perceptible.

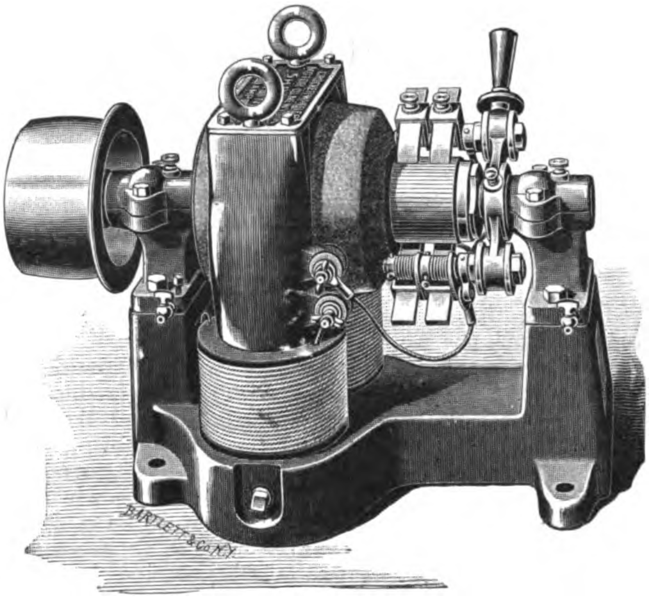

BARTLETT & CO. N.Y.

FIG. 2.—CROCKER-WHEELER 5 H. P. MOTOR

The bearings are all of the self-oiling type which do not require attention oftener than once in two to four weeks. The arrangement of these bearings is shown in Fig. 3. The base of the pillow block is hollow and contains a supply of oil which is carried over the shaft by two rings which travel upon the latter, and are caused to revolve by its motion. They dip in the oil and carry it continuously to the upper side of the shaft.

The bushings or brasses in which the shaft runs, rest, in turn, in universal, or ball, joints in seats of babbit metal in the pillow blocks, so that the bearings are sure to assume perfect allignment when the shaft is introduced. After the motor has run a month, the old oil containing the grit, etc., is drawn off by the pet cock at the base of the pillow block. This cock is then closed, and fresh oil is introduced by removing the thumb screw in the pillow block cap on top.

The brushes are held by a rocker arm which can revolve freely around the entire circle, without fear of the brass connecting parts "grounding" against the frame, a great advantage in special work where motors are to be adapted for use in unusual positions.

With the form of armature core employed, which reaches close to the field magnets, and the high grade of wrought iron used for the latter, the magnetism and therefore the power of these motors is maintained with a large reduction in the amount of wire employed. This great saving of wire not only reduces the weight of the machine, but materially increases its efficiency.

The speed of all the Crocker-Wheeler motors is very low. This, in many cases, makes countershafting, etc., unnecessary. Noiseless running is aided by the solidity of the base, which is of cast iron in one piece, forming also the yoke of the field magnets. This one casting is the heaviest part of the machine, and therefore brings the centre of gravity very low, securing steadiness and stability. The proximity of the armature core to the field magnets renders a high magnetic pressure unnecessary; therefore the magnetism escaping from the fields is very much reduced, so that no perceptible effect is produced at a short distance from the motor.

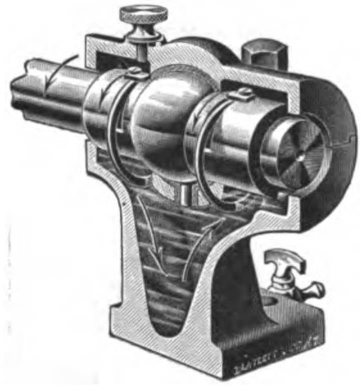


Fig. 3.—Detail of Self-Oiling Bearing.

The best double insulated wire is used throughout for the windings, the cores being first wrapped with oiled paper and heavy canvas saturated with shellac, and the motors are severely tested for insulation, none being passed with an insulation resistance of less than one megohm.

In every motor there are four ends to the wiring, two from the field and two from the armature. On all large motors built by the Crocker-Wheeler Co., these are led to four binding posts, the two field connections being made to the lower ones and the two armature connections being made to the upper ones, as shown in the diagram, Fig. 4.

In most cases one terminal of the armature and one of the field can be supplied by one outside or connecting wire, provided the other terminals are supplied by separate wires. Consequently the first connecting wire may be attached to the two posts marked 2 and 4. In the smaller size motors these binding posts are made as one, as shown in Fig. 5. Occasionally, however, the fourth binding post is put on, as indicated by the dotted line, when, for special purposes, such as when a reversing switch is used, it is necessary to have armature and field entirely separate.

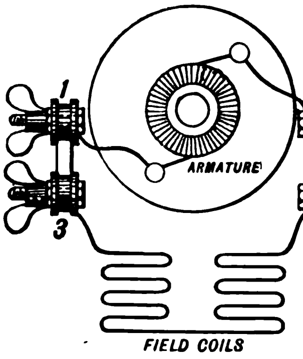


Fig. 4.—Terminals and Inside Connections of Large Motors.

In connection with the motors designed for incandescent circuits, there is provided a fire-proof and indestructible regulating box or rheostat for starting, stopping and varying the speed of the machine. This box is built entirely of slate, china and iron, neatly japanned. The arrangement of contacts in the switch on top of the regulator is such that both the field and armature of the motor are charged by the single operation of turning the knob, making it impossible to put the current on the armature before the field is charged, which has heretofore so often been the cause of the accidental burning out of motors.

The field is first charged through a small resistance coil, which is put in for the purpose of preventing a too sudden change in the magnetic strength of the latter, as well as to divide the spark when the motor is disconnected. The coils used for starting the armature are all of the same size of wire, carefully tried for carrying the full current of the machine at all speeds. With this fire-proof regulator the motor can therefore be slowed down and left running at any desired speed, indefinitely, and the usual caution, "Never to leave the box half turned on for fear of overheating and fire," is unnecessary.

The rocker arm is provided with a heavy insulated handle to enable all adjustments to be made without touching the conducting parts, and the entire machine is heavily japanned and baked at a high temperature, thus securing a polished surface which resists dirt and oil.

In addition to all these excellent features we may add finally a new departure, which consists in the fact that the name plate has stamped upon it not only the current, voltage and speed of the machine, but in addition thereto, the "constants" of the armature, the number of turns and size of wire, etc.

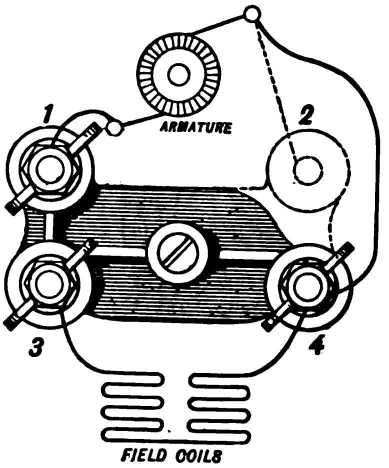


Fig. 5.—Terminal and Inside Connections of 1-4, 1-2 and 1 H. P. Motors.

PHOTOGRAPHIC REGISTRATION OF THE MOVEMENTS OF THE SEISMO-MICROPHONE.

According to the *Rivista Scientifico-Industriale*, Signor Baratta, finding some defects in the method of mechanical registration of the motions of the seismo-microphone, has substituted a photographic system with advantage. The device is briefly this :—The telephone wire is connected with a subterranean microphone. Before the telephone-diaphragm, and connected with its centre by a fine aluminum wire, is a short slip of the same metal, fixed below, and having a curved piece at the top, which rests against a small mirror, movable about a horizontal axis. This mirror reflects the light from a lamp and lens to photographic paper on a rotated drum. The light is momentarily shut off every quarter of an hour, by a shutter arrangement, worked electro-magnetically by the clockwork which moves the drum.

TELEPHONES IN FRANCE.

The number of subscribers to the nine chief telephone exchanges in France was given at the end of November as follows : Paris and suburbs, 9,200 ; Lyons, 800 ; Marseilles, 600 ; Bordeaux, 500 ; Lille, 450 ; Reims, 400 ; Roubaix, 350 ; Tourcoing, 500 ; Nancy, 176 ; Cannes, St. Etienne, Nantes, Troyes, Saint Quentin have about 150, and then some thirty towns, from 50 to 100 subscribers each. The total is only about 15,000 down to the 50 limit.

GUTMANN'S NEW ALTERNATING SMALL MOTOR.

Among those who have devoted their attention to the designing of alternating apparatus is Mr. Ludwig Gutmann, of Pittsburgh, Pa., who has recently invented a small motor, applicable especially for operating sewing machines, ventilating fans and light machinery.

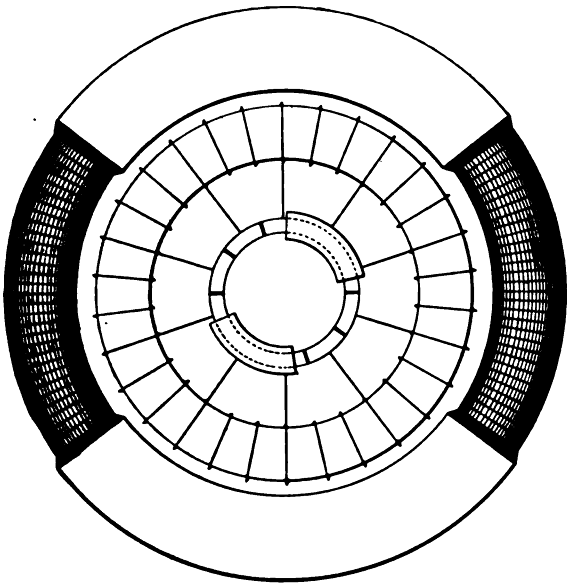


Fig. 1.—Gutmann's Alternate Current Motor.

The design of the motor is such that it starts automatically from a state of rest and operates at speeds independently of the number of current alternations, the field being energized by a single exciting current.

The accompanying engraving, Fig. 1, is a diagram of the construction, while Fig. 2 illustrates the practical form. It will be noted that the closed coil of the armature is many times subdivided, and the terminals of the subdivisions are connected to circularly arranged insulated plates. The supporting frame has four slots arranged in pairs whose members are diametrically situated, and short circuiting brushes are retained in one pair of slots by adjustable springs. When the motor is to be reversed, the brushes are changed to the remaining slots.

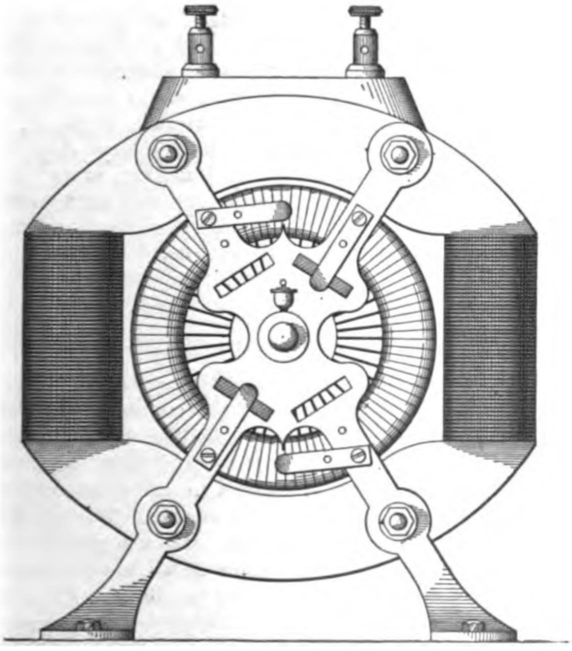


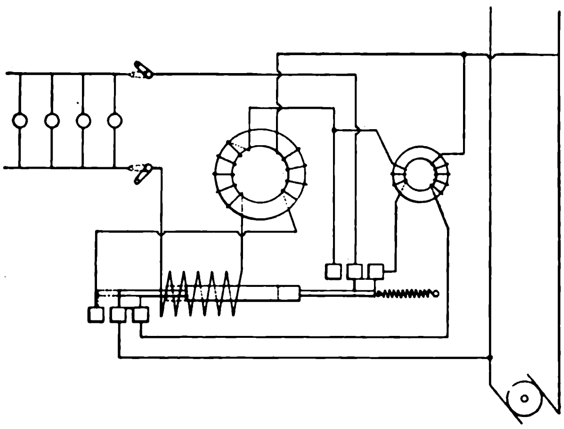
Fig. 2.—Gutmann's Alternate Current Motor.

In the operation of the machine, the brushes permanently maintain a group of the coils closed upon themselves, while simultaneously including, and excluding, therefrom, one of the small subdivisions at each end of the group, the number of subdivisions being many times greater than indicated in Fig. 1. There is substantially no more sparking than in a direct current generator, because only one very small subdivision is opened from short circuit at any given instant. It is apparent from this that the armature poles are substantially stationary with respect to the field, while the armature rotates continuously.

An important detail of construction is that of the laminated field, the iron plates of which are stamped with a single die into two parts each, whose ends are interlocked and the plates bolted together. This construction enables the coils to be wound previously on formers in a lathe, and subsequently applied to the field, effecting thereby a quick and cheap means of manufacture. The construction is also applicable to direct current field magnet motors and dynamos.

GUTMANN'S SYSTEM OF ALTERNATE CURRENT DISTRIBUTION.

It is a well known fact that the efficiency of converters varies with the load, and that as the load decreases the efficiency diminishes. This, of course, entails a serious loss of energy, and it therefore becomes highly desirable to introduce a method by which converters may be operated continuously at their best efficiency. This is especially desirable in large installations including a number of converters, where the demand for current is apt to fluctuate between wide limits.



Gutmann's System of Alternate Current Distribution.

To effect this object, Mr. Ludwig Gutmann, of Pittsburgh, Pa., has devised the arrangement shown diagrammatically in the accompanying illustration. The method consists in keeping one converter permanently in circuit and automatically introducing more and more converters into circuit as more and more current is drawn from the secondary, and *vice versa;* and of cutting in, and out, the first converter according whether little or no current, respectively, is required.

This is accomplished by means of a single solenoid and core which operates a simple switch arrangement, by which the proper number of converters are included in the circuit, depending on the load.

Cleveland, O.—The East Cleveland Street Railroad Company, at its annual meeting, elected the following directors: A. Everett, G. E. Herrick, Charles A. Otis, John L. Woods, C. W. Wasson, M. A. Bradley, H. A. Everett. Officers were elected as follows: A. Everett, president; C. W. Wasson, vice-president; H. A. Everett, secretary and treasurer.

THE INSURANCE INSPECTOR ON HIS ROUNDS.

BY

Alfred B. Braddell.

Holding the position of electrical insurance inspector, I am naturally often asked to describe the kind of work found in my territory. In answering this question I have no hesitation in saying that cheap, which is only another name for bad, work predominates.

This is not wholly the fault of the contractor or constructing electrician, but partly of the general public, who ask that the work be put in in the best possible manner, and are then too reluctant to put their hands in their pockets and pay an adequate price. Nor can the public bear the whole blame, as they are in a great measure deplorably ignorant as to the nature of the electric current, and fancy that the installing of electric wires requires no more skill than the running of a wash line in one of their back yards.

It is certainly strange that the public, knowing, especially from the daily papers, what dangers may accrue from bad work, will persist in giving their contracts to so-called engineers (plumbers, gas fitters, etc.), instead of to men who have earned their names and reputation in the business, and can command their price.

Great trouble is found in small towns where the electric light company does no wiring but simply furnishes the current. This is the opportunity for the *electrical engineers* of that town. Naturally jealous of each other they cut their prices, even doing the work below cost in order to secure the job. As a result, the work is done in a careless manner, the conductors being undersized and out of proportion, secured with metal staples, and solder being an unknown quantity.

When making inspection of these places, the consumer, mistaking me for one of the company's employés, exclaims, in not a very pleasant tone of voice, interspersed with unmentionable adjectives, that he is obliged to light a match to find his lamps. Can this be wondered at? How can the evil be remedied? Such work is not only dangerous to property, but casts a blot on the electrical profession.

When speaking to an official of an electric light company about this kind of work I was told that the consumer put it in at his own risk. Is there not a good chance here of doing defective work by outsiders? Why should a company hand over, as it seems to me, their legitimate business, and assume no responsibility? I may ask here, if the insurance companies are to take the risk also and not ask any extra premium?

If they have no faith in their electrician, let them pay one in whom they can place reliance.

Let them guarantee safety to their customers, and place their confidence in their electrician, and so build up a reputation for themselves and the electrical business.

The following are a few incidents met with in my rounds:

Being asked to inspect a certain isolated plant, a man was detailed to conduct me through the premises. Not being able to trace out the different circuits, I asked him to draw them on a piece of paper. This he could not do but said he would call the electrician. After waiting a few minutes I heard a voice asking if I wanted to see him. Turning round I beheld one of the colored fraternity. I asked if this was the electrician and got an answer in the affirmative. My first question was, "What is the potential of your machine (one of the Edison type)? Answer: "500 volts." My next, "The E. M. F. of lamps?" Answer: "Oh that's where you've got me, Boss." I examined one of the lamps and as well as I remember it was marked 110 volts. I then explained that lamps of that E. M. F. could not be run from a machine having the potential as he stated. His answer was that he "guessed" I was right.

Arc lamps were placed in multiple series on this circuit, a very primitive resistance being in series with the same. The latter was made as follows: Three porcelain insulators placed in the form of a triangle on a piece of board, a coil of German silver wire (of apparently unknown resistance) resting on these, the ends being simply twisted around the copper conductors. The first of these inspected was broken in two, and another had become so greatly heated that the surrounding wood work of the building was considerably burned.

In another building an incandescent machine was being placed. The machine was set on a stone foundation, the bed plate being bolted directly to it without any insulating material whatever. On telling the man in charge that I did not consider it a very good method, and that I should prefer dry wood placed under the machine, he commenced an argument that stone was a better insulator than wood.

I was told a very good story of a man in charge of a plant I had occasion to visit, who directed one of his subordinates to give a machine a thorough cleaning. During this operation an ammeter which was in circuit was removed; when connecting up again this was reversed, thereby sending the needle in the opposite direction. When the man in charge observed this phenomenon he was greatly puzzled and could not understand why the "darned" instrument should be so erratic.

I will add but one more. On examining a joint in a building I found it wrapped with tin foil; on further examination I discovered that all the others were in the same condition. On meeting the individual who manufactured these, we held a somewhat lengthy and heated argument, on tinfoil versus solder, in which he claimed that the former afforded more carrying capacity for the current. I presume it is unnecessary to state the verdict.

The above are fair samples of some of the work as found, and the kind of men in charge. I do not wish it to be inferred that there is no good work being done; far from it, for where there is a reputable man in charge and no stint in price, work of a high character is the result. In many of the isolated plants there are practical mechanics having a good electrical knowledge in charge; but these are at a discount, the majority, as they have acknowledged to me, being "all right as long as the machines are."

As far as the central station for light or power is concerned, the day for placing delicate and expensive instruments and machinery under a "frame shanty" is disappearing, and good substantial brick or stone buildings are being erected. The construction, material, fittings, etc., for these is reaching a higher standard every day, and, calculating upon the present rate of building, it is only a question of a very short time when every city and town in the country will avail itself of one of the most powerful forces with which nature has endowed us.

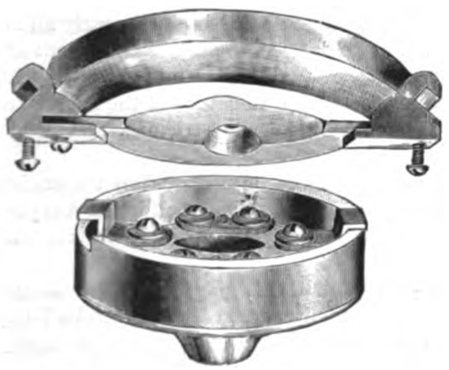
AN ELECTRIC RAILWAY LEAGUE.

It is proposed to form a mutual benefit society of the men employed on electric railroads throughout the country, with headquarters in Boston. Employés to be eligible for membership must be between the ages of twenty-one and fifty, must have some knowledge of electricity as applied to railroads, and must have worked on an electric road for six months. The admission fee will be $2, with quarterly dues of $1. When a member dies, each man will be assessed from 50 cents to $1 for funeral expenses, etc., and in case of illness, a member will be allowed $7 a week for a month, with further relief when necessary. The organizers propose to have the whole country divided into districts, with headquarters in each, all subject to the Boston lodge. If a member is out of employment, the order will seek to find a position for him, if worthy, and in case of necessity, will advance him money.

The order is not to be confused with, or regarded as, a labor organization, and no member will attempt to dictate to a company, or will take part in strikes.

A NEW ROSETTE CUT-OUT.

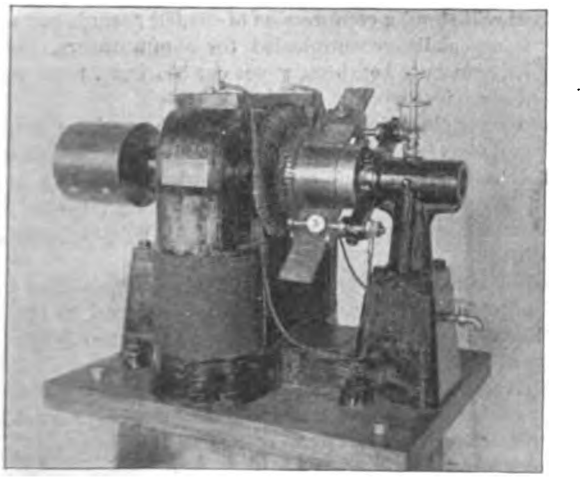
The accompanying illustration shows a new porcelain rosette cut-out, recently introduced by the Electric Engineering & Supply Co., of Syracuse, N. Y., which deserves much credit for its substantial design and neatness of finish. The porcelain base, which is also made in Syracuse, is particularly tough and will stand hard usage, obviating the trouble often experienced by line men, who in screwing up cut-outs crack the bases. The connections which screw to the line are milled smooth, so that the ears in the cap, to the opposite end of which the fuse is connected, fit into the slot milled in the side connection brasses. One of the ears enters at the side with one screw, as shown in the cut, and the other ear, by swinging the cover round, is pressed into the slot on the other side of the rosette, until it has reached its proper place, when it is stopped by the porcelain. With this design of cut-out very rapid work can be done, as it is only necessary to make the usual connections, after which the cap is put in place and half a turn of the screw driver permanently clamps it in position.



A New Rosette Cut-Out.

THE NEW KEYSTONE MOTOR.

The accompanying illustration shows a new type of motor built by the Keystone Electric Company, of Erie, Pa. This motor has a large steel shaft with long bearings running in self-aligning brass boxes, with oil cellars to receive the drip, which may be filtered and used a second time. It is well protected from external injury to winding, and its general make-up is one of strength, while avoiding undue massiveness. It runs noiselessly and without sparking under variations of load. The armature is of the Gramme ring type, of medium diameter, and supported on the shaft by means of a heavy brass spider. The coils are separated by insulation which makes a burn-out almost impossible.



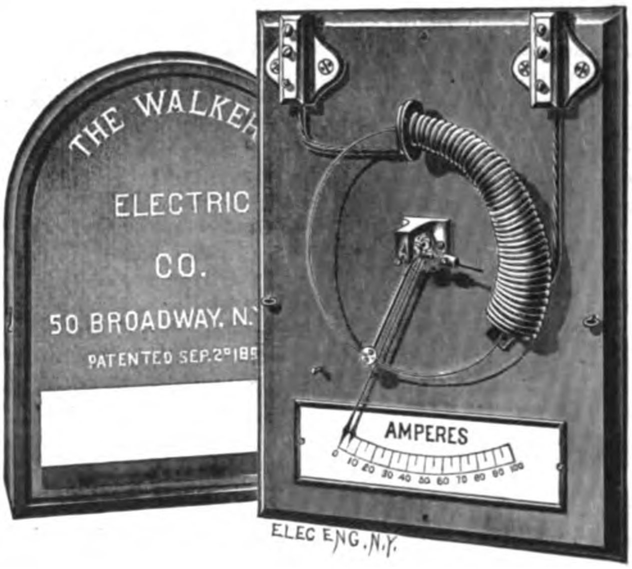
The Keystone Motor.

The 3 h. p. machine makes 850 revolutions per minute, and weighs about 400 pounds.

THE NEW WALKER AMMETER.

Some time ago we described and illustrated a very ingenious electric meter devised by Mr. George W. Walker, electrician of the Walker Electric Company, of this city. With this instrument, it will be remembered, a continuous record of the current strength is obtained by photography on a moving roll. At the end of the month the roll is removed from the motor and measured up. The accuracy obtained is almost absolute, and the record is one which is at all times open to inspection and verification.

More recently Mr. Walker has devoted his attention to the designing of a series of voltmeters and ammeters which shall embody both simplicity and accuracy. The ammeter in its present form is illustrated in the accompanying engraving. As will be seen, it consists of a solenoid having as a core a soft iron wire bent in the form of a circle. This wire is pivoted on jeweled centres and carries a pointer passing over a scale. The current passing through the solenoid draws in the core in proportion to the current strength, and the evenness of the divisions of the scale is obtained by the conical winding of the solenoid employed. The instrument shown is designed for a range of current from 0 to 100 amperes. Others are made for smaller and larger ranges, as desired. A series of voltmeters have also been designed by Mr. Walker on the same principle.



The Walker Ammeter.

ERECTION OF POLES IN NEW YORK.

Commissioner Gilroy proposes that it shall be made unlawful hereafter to erect any post or pole for carrying electric wires in front of the entrance of a dwelling-house in this city, or near a street corner upon a line with a crosswalk, or within a distance of ten feet of a street lamp. Poles or posts carrying electric wires are to be painted a light brown color a distance of ten feet above the sidewalk, the rest to be painted white. This will not apply to poles having a fire-alarm box, which are to be painted red. The owner's name, also, is to be branded on the pole in a conspicuous place, and no sign, poster or advertisement shall be placed upon such pole. An ordinance covering the points named, and prescribing penalties for its violation, was introduced in the Board of Alderman last week by Mr. Brown, at Mr. Gilroy's request, and referred to the Law Committee.

ENCOURAGING ELECTRICAL PROGRESS.

BY

Wm S Eaton

NOT very many months ago the superintendent of a large manufacturing concern was approached by a mechanic employed in the factory, and shown the drawings of an electrical attachment which could be adapted to a considerable extent to the machinery in use in one of the departments. He looked the drawings over and listened patiently to the verbal description of the proposed improvement, and encouragingly remarked, "Oh, pshaw! I don't take no stock in them electricity ideas." This man was as well posted on matters electrical, as he was on matters of grammar; and he condemned off-hand a device that he could not understand, and threw an obstacle in the way of what subsequently proved a very valuable improvement.

The originator of the idea alluded to, chanced to be a grade higher than a workman at the bench, and inasmuch as he was connected directly with the department using the machines, he, on the first opportunity, presented himself to the foreman having in charge these machines, and explained the idea to him. To use a common expression, this new man "caught on" at once. The apparatus necessary was of very simple character, and by taking the magnet from an unused electric-bell, and some few bits of iron and copper, bent and twisted, and filed "on the sly," they soon had the thing in working order. Two small Grenet cells furnished the current, and the thing worked like a charm. The proprietor of the factory was shown the device, and by his order one machine was fitted up properly with the electrical attachment, and the result surpassed all expectations. It is needless to say that an immediate order was given to fit *every* machine with the improvement, and to-day nearly twenty machines are fitted as described, in that factory, and doing a grade of work up to that time believed to be impossible, and at a saving of thousands of dollars annually.

As long as such silly prejudice exists against electrical progress, the electrical engineer will have a hard row to hoe. It is almost beyond belief, that, in order to benefit your employers, you must (in some cases) do it by stealth and like a criminal fearing discovery and exposure. The facts related above are strictly true, and come entirely within the writer's knowledge.

The field of invention is boundless, and the many new discoveries, instead of restricting the field, actually broaden it for wide-awake inventors. Nearly every new invention brought out suggests an application of its principles to some use not thought of by the inventor; generally speaking, the best field for the adaptation of such ideas is one that is least explored, that is, the field of manufacturing industries. Certainly, it is out of the question for electricians to know every purpose to which their inventions may be adapted. This much I do know: that the principles shown us in such machines as Mr. Berliner's gramophone, and Mr. Edison's phonograph are capable of being put to valuable uses in other directions than those intended by either of the inventors mentioned. *They* will probably devote their energies to perfecting their machines for the recording and reproducing of sound, and lose sight of other commercial uses to which the principle underlying their discoveries might be successfully applied. This is not to be wondered at, of course, and perhaps is best as it is.

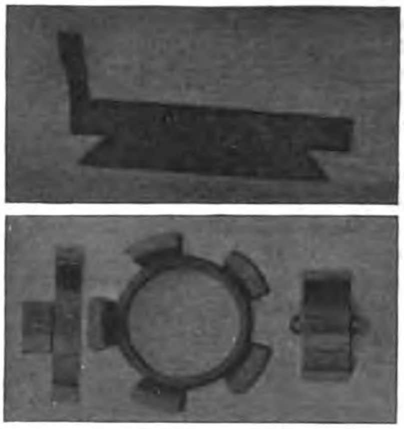
But this fact is emphasized, that men in authority in manufacturing concerns would do well to study thoroughly the progress made in electricity and the kindred sciences, and apply the knowledge thus acquired to uses in their own establishments. The result would be astounding; profits would increase, labor would be lightened, and the world be so much the happier. Yet I hardly look for any such good fortune. On the contrary, ignorance and prejudice, as described in the beginning of this article, will continue to flourish, and electricians will have to worry in the future, very much as in the past. Yet the time will come, Eli, when we will "get there with both feet."

EUREKA TEMPERED COPPER.

As is well known, copper is the basis of nearly all anti-friction metals, although in its native state it lacks sufficient strength for bearings and must be hardened by alloying it. This process, however, changes the whole structure of the copper from fibrous to granular, decreasing its tensile strength, and leaving it hard and brittle.

That copper was hardened or tempered by the ancients, no one can doubt, as edge tools and relics of all kinds composed of pure copper have been found, and are now on exhibition in countless collections.

The process by which this tempering was accomplished is claimed to have been re-discovered by the Eureka Tempered Copper Co., of North East, Pa., who are prepared to supply all kinds of copper cast solid, and tempered to any gauge that the work expected of it demands. This copper has a tensile strength of 64,480 pounds, and will stand a compression of 190,000 pounds per square inch. It is especially recommended for commutators, brushes, gear pinions, armature bearings, street car bearings, trolleys, and all kinds of electrical work.



FIGS. 1 AND 2.—DYNAMO PARTS MADE OF EUREKA TEMPERED COPPER.

The accompanying illustrations show some castings made by this company for various electrical concerns. They are all standard makes, and will be readily recognized. In Fig. 1 is seen the motor commutator of the C. & C. Electric Co., while Fig. 2 shows commutators of the Thomson-Houston, Westinghouse, and Brush patterns.

Tempered copper wire has nearly three times the tensile strength of ordinary copper wire, and is claimed to last three times as long. In the catalogue of the Eureka company are given the results of tests made at the Franklin Institute, the University of Pennsylvania, and the Union Iron Works of Pittsburgh, as well as a number of the most flattering testimonials from railroad and electric companies in all parts of the country.

PORTLAND, ME.—The Atlantic Telegraph Company has elected the following directors for the ensuing year: John W. Deering, of Portland; John J. Donovan, John F. Kimball, of Lowell; Henry P. Dewey, George P. Wescott, of Portland; Thomas G. Gerrish, Jr., Nathan D. Pratt, of Lowell. After adjournment the board met and organized by electing John W. Deering, president; John J. Donovan, treasurer, and Nathan D. Pratt, clerk.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XIV.

(*Copyright The Electrical Engineer.*)

BY

Herbert Laws Webb

In averaging the capacities of a number of wires of the same length (such as the different conductors of a telephone cable) when the deflections vary, it is not necessary to work out each deflection separately and average the results, as was shown to be the case in averaging the insulation resistance of a number of wires. The average capacity can be worked out from the average discharge deflection. The reason for this is simple and obvious. With the insulation test the constant is divided by the deflections, and if these vary much, the average of the results of each deflection worked out separately will not agree with the result obtained by working out the average of the deflections; it is advisable therefore to take the average of the insulation resistances of the various wires in order to state the average insulation resistance of the cable. In the capacity test, however, we divide the deflections by the condenser discharge, and the divisor therefore remains unvariable. It is obvious that the average will be the same, whether it is determined by averaging the capacities of the separate wires, or averaging the deflections and working out the mean deflection.

A simple example will serve to make this clear. Having from a condenser of .1 microfarad capacity obtained a discharge of 200 divisions, we take discharges on six wires in a cable which give deflections of 240, 250, 250, 260, 240 and 260, respectively. Dividing by 2,000 we find their respective capacities to be .12, .125, .125, .13, .12 and .13 microfarad. The average capacity of the six will be .125 microfarad. Now summing the deflections we get 1,500, which, divided by 6, the number of wires, gives a mean deflection of 250. Dividing this by the condenser discharge 2,000 we obtain the same result, .125 microfarad, as the average capacity of the six wires.

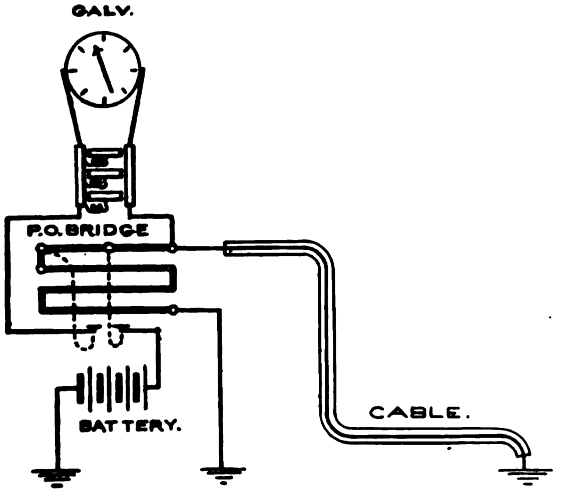


Fig. 34.—Connections for Resistance by Post Office Bridge.

In testing a telephone cable it is usual to test about twenty conductors for capacity; as the deflections will probably vary throughout by a few divisions, it is more convenient to obtain the average by working out the mean deflection, than by summing the capacities of the wires. When testing a telephone cable for capacity, all the wires, except the one being tested, must be grounded. A test made with the cable not grounded would show a lower capacity, owing to the much greater thickness of insulation surrounding most of the wires. This would not be the capacity of the cable under working conditions and the test would be worthless as an indication of the quality of the cable. In this type of cable it is sometimes desirable to test the capacity of a pair of wires, the ends being connected together at the further terminal of the cable, and the end of the second wire joined to one pole of the battery and the galvanometer, the earth connections being removed. The capacity of the loop will be one-half the capacity of one of the conductors, or one-quarter the capacity of the entire length of wire contained in the loop.

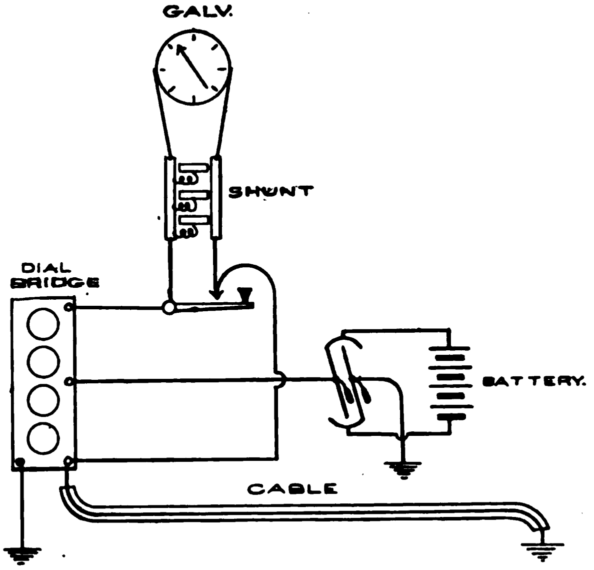


Fig. 35.—Connections for Resistance by Dial Bridge.

In making factory tests for capacity, when a long length of cable wound on a drum is to be tested, the sheathing of the cable should be grounded, the ground connection being made with great care, in order to avoid inductive action between the different turns. In testing single wire cables for capacity, when coiled up, it is best to connect both ends to the instruments in the manner described above, no earth connection being employed. In this way any possible error, by reason of induction from one turn to another, will be eliminated. As already explained, a wire connected in this way will only receive one-quarter the charge that it will take with one end free; therefore the apparent capacity must be multiplied by four to obtain the real capacity of the wire.

TEST FOR CONDUCTOR RESISTANCE.

The principle of the Wheatstone bridge for measuring the resistance of conductors has already been explained, but may be appropriately recapitulated here. It consists, briefly, in offering two paths for the battery current, one along the conductor to be measured, and the other by the variable resistance; by connecting two points in these separate paths through a galvanometer or other instrument (such as a telephone) capable of indicating the existence of a difference of potential between the two points, the variable resistance can be intelligently manipulated until equal potential at the two points is reached; the resistances of the two paths open to the current are then equal, and the resistance of the conductor can be read by the value of the variable resistance in circuit. In referring to the schematic diagram given in the introductory chapter, the analogy employed was that of an ordinary balance, the arms of the bridge being the beam, the adjustable resistance the weights, and the galvanometer the pointer. This was assuming the arms of the bridge to be of equal value, as the two halves of the beam always are. But the bridge has a far wider range of measurement than this, which would limit our measurements to the total value of the resistance coils. Pursuing the analogy of the balance, the arms of the bridge, being adjustable, constitute a sort of reversible steel-yard, and by altering their ratio we can make our weights a thousand times heavier than they are by themselves, or a thousand times lighter, enabling us to weigh accurately with the same set of weights, either very heavy or very light bodies, or in other words, to measure very high or very low resistances. This property alone is sufficient to stamp the Wheatstone bridge as the most beautiful measuring instrument known to science.

As already described, the arms of the bridge each contain three coils having resistances of 10, 100, and 1,000 ohms respectively; some bridges have two additional coils of 10,000 ohms each, and bridges are occasionally made with five coils in each arm, the lowest of one ohm, and the highest of 10,000 ohms resistance.

If we desire to measure a resistance with an accuracy of one ohm only, the ratio of the arms must be equal, that is, two coils of equal value must be unplugged. In any case, two of the proportional coils must be unplugged when making measurements with the bridge, or the galvanometer will be short-circuited and no readings obtained.

If a small resistance is to be measured and the result is required to fractions of an ohm, the resistance in the arm nearest the coils must be made larger than the resistance in the arm to which the unknown resistance is connected. Thus, if we unplug 100 in the B arm (the left in the Post-office bridge and the right in the dial pattern) and 10 in the A, the current strength in the variable resistance will be one tenth of that in the unknown, and the value unplugged in the variable resistance will be ten times greater than the unknown resistance. When balance is obtained, the resistance unplugged, divided by ten, will give the resistance of the conductor being measured.

It is plain, therefore, that, as we can make the ratio either way, 10 to 100, 10 to 1,000 or (with the dial bridge) 10 to 10,000, we can give to each ohm in the variable resistance a value of $\frac{1}{10}$, $\frac{1}{100}$ or $\frac{1}{1000}$ of an ohm, or a value of 10, 100 or 1,000 ohms, according to whether we are measuring low or high resistances.

A simple rule to remember, calling the arm nearest the coils *b*, and the arm to which the conductor to be measured is attached *a*, is: When measuring low resistances make *b* higher than *a*, and when measuring high resistances make *a* higher than *b*. In the Post-office bridge *b* is on the left when the keys are nearest to the manipulator; in the dial bridge the ratio coils are placed in front of the dials and *b* is to the right. Fig. 34 shows the connections for measuring conductor resistance with the Post-office bridge, and Fig. 35 with the dial bridge. In these diagrams it is assumed that only one end of the conductor is available for connection to the instruments, the other being put to earth. In this case the end of the variable resistance, *i. e.*, the bridge coils, and one pole of the battery are also put to earth. The general similarity between these diagrams and that shown in Fig. 7, is easily apparent.

If both ends of the conductor to be measured are available, the second end is connected to the terminal of the coils, the second pole of the battery also being joined to the same point. As these three connections were all to earth in the previous case, it is obvious that joining them together in no way alters the flow of current in the system. When measuring the resistance of a loop in this manner with both ends connected to the bridge, it is best to disconnect the earth wire entirely, as otherwise some difficulty will probably be found in obtaining a balance. For this reason, if the terminal plate for earth connections is used, it is best to have it made so that the earth terminal may be cut off from the rest by means of a plug, as previously suggested.

It will be noticed that the adjustable coils are joined to the ratio coils by two brass blocks between which a plug is inserted. This plug, which is termed the "infinity" plug, should always be in place when the bridge is being used for measuring resistances, otherwise the coils are *disconnected* and the resistance is of course infinite. If it is desirable to use the coils merely as a resistance, such as for making a shunt, the removal of the infinity plug serves to disconnect them from the ratio coils.

In the dial bridge there is a pair of blocks with a connecting plug at the end of each set of ratio coils. The plug to the right is the infinity plug and should be in place; that to the left should be removed when measurements are being made, or the conductor being tested will be short-circuited and balance made impossible. As a matter of fact, the coils being between the two terminals at the extreme ends of the brass blocks, either plug could be used as the infinity plug, provided that the unknown resistance were connected at the opposite end of the instrument, but it will be found more convenient in practice to keep to one method of connecting up.

TWO NEW HILL SWITCHES.

A good switch is one of the most important features in an electric light installation, and we therefore illustrate two novel switches just designed by Mr. W. S. Hill, of 133 Oliver street, Boston, which form an important addition to his already very complete line. Fig. 1 shows a double pole transfer switch, having two sets of terminal contacts, either set of which may be put in connection with the dynamo at will, thereby transferring the current from one dynamo to either one of two separate circuits, or to connect either one of two dynamos with one circuit. Fig. 2 shows a new dynamo switch designed to be used at the dynamo, or on the switchboard between the dynamo and the main line. It consists of one of Mr. Hill's ordinary switches and a main line fuse block combined, mounted on one base of slate, and is a very compact and substantial piece of apparatus.

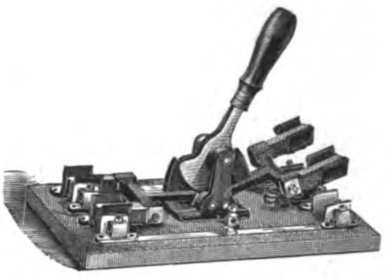


FIG. 1.—NEW HILL SWITCHES.

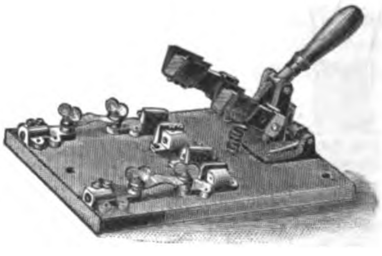


FIG. 2.—NEW HILL SWITCHES.

WORCESTER, MASS.—The Electric Light Company, at the annual meeting, elected the following directors: Thomas M. Rogers, Stephen Salisbury, A. B. R. Sprague, Theo. C. Bates, S. E. Hildreth, Josiah Pickett, Samuel Winslow, Loring Coes, N. S. Liscomb, W. A. Denholm, Alzirus Brown; treasurer, Herbert H. Fairbanks; superintendent, W. H. Coughlin. The directors re-elected T. M. Rogers president.

THE ELIESON ELECTRIC METER.

Among the numerous principles which may be applied to measure the volume of current passing through an electric circuit is that depending upon the electrolysis of a liquid, such as water. The gas generated can be readily collected and its volume measured, which thus affords a simple means of metering the current.

In applying this principle Mr. C. P. Elieson, of London, at present in this city, has devised the several forms of apparatus. It is evident that to acertain the quantity of current which has passed through a circuit we may meter either the volume of gas generated or register the pulsations caused by the accumulation of the gas as it is generated.

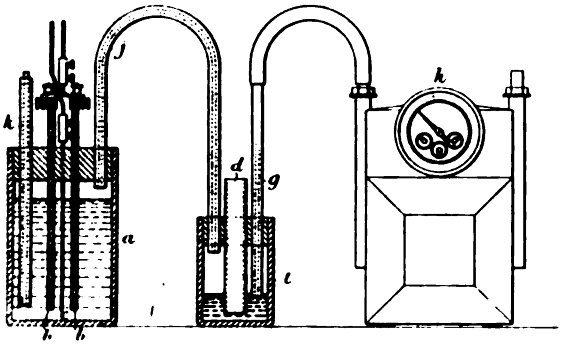


Fig. 1.—The Elieson Electric Meter.

Mr. Elieson has carried out the first method in the apparatus illustrated in the engraving, Fig. 1. Here a closed vessel *a* containing acidulated water is provided with electrodes of carbon for the negative, and platinum for the positive, which are connected with the main conductors. The tubes *d* and *g* are inserted in the vessel *i*, containing mercury, and which is connected with the vessel *a* by means of a tube *j*. *k* is a tube through which the vessel *a* is supplied with liquid, the tube being closed at the upper end.

By this arrangement it will be readily understood that the gas generated by the electrolysis or decomposition of the liquid in the vessel *a* will pass through the tube *j* into the vessel *i*, causing the mercury to rise in the tubes *d* and *g*, and as soon as the lower end of the tube *g* is exposed the gas will escape through the tube *g* into the meter. By this means the gases are kept under a constant and equable pressure without the necessity of maintaining constant the level of the liquid in the vessel *a*.

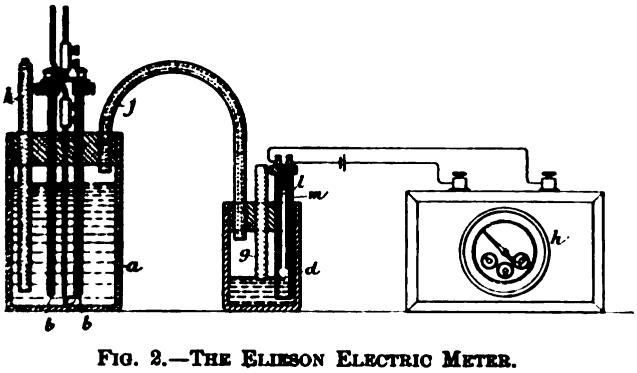


Fig. 2.—The Elieson Electric Meter.

In the second type of meter above referred to, depending upon the registration of the pulsations caused by the accumulation of gas, Mr. Elieson employs the construction shown in Fig. 2. This meter is practically identical with that illustrated in Fig. 1, except that instead of the gases generated escaping through the tube *g* into a meter they are now allowed to escape freely through that tube; but as the mercury rises in the tube *d* it completes an electric circuit by means of two wires *l m* in the tube *d*, so as to short-circuit an electro magnet which actuates a counter *h*. Directly the gases escape, the mercury falls, as before, thereby breaking the circuit, and so on, continuously, so that each pulsation caused by the accumulation of the the gases generated is registered.

For measuring alternating currents it will be obvious that one or both of the electrodes must be made relatively small and of suitable material, such as platinum. Where a current of electricity of a certain quantity is to be measured—that is to say, a current not below a minimum required for, say, supplying a few lamps—then the gas generated need not be compressed, but can pass direct to the meter.

A CHART OF WOODEN CLEATS.

The advent of electricity as one of the prominent modern industries created a demand for cleats for the supporting of wires, and this demand has steadily increased from the very inception of the art. When conductors carrying heavy currents became a necessity, certain regulations had to be made for the safe running of wires, and the underwriters' rules in this regard are well defined and pretty well understood.

Heretofore the manufacture of cleats has, to a great extent, been confined to furniture manufacturing and other similar establishments, where the small stock which would otherwise become waste was used for this purpose, this branch of the business being treated as a side-issue. But as the demand for cleats, as well as all other kinds of material needed in electrical construction work steadily increases, manufacturing establishments are springing up in every direction to supply this demand. The quantity of cleats needed at the present time is enormous. They are made of different materials, such as porcelain and various compounds; but these modifications and refinements have not as yet come into such general use as to interfere seriously with the old-fashioned wooden cleat, as wood costs less and answers all the essential requirements, cleats never being used in proper construction except where everything is dry and the wires are not liable to be disturbed.

The various sizes and designs of cleats in general use are illustrated in the accompanying chart. Those used for electric lighting purposes, it will be noticed, have a distance of 2½ inches between the wires, except numbers 400 and 401, where the distance is increased. This latter style of cleat is used where the wires are run along brick and fire-proof walls before the plaster is put on. Its office is simply to hold the wires in position until the plaster is hard, and it is called the "plaster cleat." The others shown are those which are used for open and surface work and when well and symmetrically made present a neat appearance.

The Independent Bung Co., of this city, to whose courtesy we are indebted for the use of the chart, arranged by Mr. M. C. Sullivan, manufacture all kinds of cleats, the special machinery for the purpose of producing the cleats having been designed by Mr. H. B. Wheatcroft, of that company.

Owing to the fact that the different makes of insulated wires have such varied diameters, caused by the difference in the thickness of insulation, it is a difficult matter to determine absolutely the size of the grooves that will apply in all cases; but a difference of one-eighth inch in size will be found to cover a very wide range.

The value of a chart such as here presented can be appreciated when it is considered that past experience has developed the most vexatious delays and annoyances in ordering cleats, owing to the absence of any catalogue from which to select the exact size. This is particularly true in cases where practical men have been compelled to work at distances from the home office, and having occasion to order supplies, had nothing to express their wants except a description, which has in a great many cases failed entirely, occasioning delays and expense. By the use of this sheet, the ordering of cleats in the future will be a very easy and satisfactory matter.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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The hum of the electric motor is a song of emancipation.
—*Frank J. Sprague.*

RETROSPECT AND PROSPECT.

ONE of the most interesting features of the meeting of the National Electric Light Association at Providence this week is the celebration of the first decade of commercial, practical electric lighting in this country. If the retrospect be taken in the right spirit, there is always advantage in surveying, at the end, its toils and dangers over, the road we have traveled ; and in casting the backward glance upon the vicissitudes and advances of electric lighting, much good will be derived if only in the way of stimulus. An English statesman who had been engaged in a great reform movement, once suggested to his hearers that as they had reached the hilltop, they might as well "rest and be thankful." The sentiment is not without merit, but is evidently suited to people of a more lymphatic temperament than Americans. If there is one thing we do, it is to press towards the mark of perfection that has not yet been attained in any art and which during the past ten years in electric lighting has barely become visible.

Ten years ago there was electric lighting, but no electric light art. To-day, by stages of evolution and across the debris of "systems" that have had their day and ceased to be, we have arrived at definite and fairly satisfactory ideas in construction and practice. Principles have been determined and methods have been standardized. Moreover, there is a clearer understanding of the things to be aimed at. The central station is no longer regarded as a kind of feudal stronghold for either arc light or incandescent lighting or for some single, special variety of them. Time was, and not very remote, when the tribal warfare frightened and bewildered the public, until at last peace was often vouchsafed only through the exhaustion of the combatants and their extinction in each other's embrace. Even now the progress of the industry is retarded by such bellicose displays, but on the whole it may be said that the art has cleared itself pretty thoroughly of the contests and litigations that have preyed on its profits and prejudiced its prosperity. A central station has become a place from which a customer expects any kind of light or power service that he has a mind to call for ; and if told that he cannot get this or that, the customer is as much surprised as though his newsdealer would only sell him papers of one political stripe, or his tobacconist refused to carry a popular brand of cigars. One of the main things learned in these ten years is that a station exists to manufacture current on as large a scale and as economical a plan as possible, and that the station is most successful that leaves its patrons the freest to decide on the size of the units of light and power that they want. Another great point learned is that this current should be metered. A third lesson is that cheap work is the dearest in the long run. This last point may not seem very striking but there were not a few men who thought that electricity was to be the exception proving the validity of the rule.

This idea that a central station is a current factory is beginning to permeate. Arc lighting has been supplemented and even surpassed by incandescent lighting. There has arisen the demand for motors, and now heaters and welders ask for a place on the circuits. The successful inventions of the immediate future are those which shall harmonize and satisfy these needs from the one plant.

As for the Association, it is true that it has not yet completed a decade of existence, but it may wisely avail itself of this period of review and retrospect to invite attention to its excellent work since 1885, and to ask for new and enlarged support. The Association is a representative body solely on account of its creditable record and its widespread influence, and not at all on account of the largeness of its membership. But it ought not to stay at its present low total of members. Already there are 1,500 central station plants at least, and new ones are organized every week. The proportion of active membership from these local companies ought to be ten times as large as it is now, and the best way to celebrate the first decade will be to take steps for an active canvass and propaganda that will place the Association in the very front rank among bodies formed to promote and protect the interests of great industries.

MODERN ELECTRICAL ENGINEERING.

THE promising character of electrical enterprises early in the art induced many to enter this field, who by training were very ill-prepared to carry out work in the manner which the experience of late years has demonstrated to be necessary. As a result, not only bad electrical, but bad mechanical, designs in electrical apparatus were not infrequent, and hence probably has come the dictum, sent forth it is true by high authority, that the electrical engineer ought to be nine-tenths mechanical and one-tenth electrical. As Prof. Crocker points out in another column, however, the times have changed rapidly, and to-day the relative proportion of electrical and mechanical make-up required in the competent electrical engineer may be fairly said to be nearly the reverse of that designated above. In other words, as he forcibly remarks, the electrical engineer ought to be an engineer in the broadest and best sense of the word. Who but one thoroughly versed in electrical principles and their application can be depended upon to bring about the great improvements which are looked forward to, involving simplicity in the armature, commutator and brushes, means for avoiding sparking, etc.? It is on these lines largely that Prof. Crocker has laid out his course of instruction at Columbia College, as described in this issue, and while not ignoring the proper importance of mechanical engineering as an aid to the work, we believe that he has taken a right view of the case and subordinated the mechanical to the electrical part of the course at Columbia.

MR. SPRAGUE ON THE RAPID TRANSIT PROBLEMS OF NEW YORK.

As we have already noted, the *Commercial Advertiser* has been devoting a generous portion of its space to the opinions and ideas of electricians and electrical engineers on the solution of the rapid transit problems of New York. That space has been well bestowed, for electricity will have more and more to do with passenger and freight transportation as the years roll by, and these are the times when the work is taking shape. We are now glad to note that the *Commercial* has left to Mr. Frank J. Sprague the summing up of the main points of the situation and of the argument, and in its issue of Monday last has devoted a whole page to his treatment of the question, in the form of a very able and cleverly-done interview by Mr. George Heli Guy. For some years past, Mr. Sprague has been studying the New York rapid transit problem, and has saturated himself with its facts and statistics. He now stakes his reputation, which is no mean one, on the ability of the electrical engineer and inventor to deal satisfactorily with the difficulties of the case and to give New York an adequate system of underground electric transit. We shall have occasion to return to this matter, and in the meantime would advise our readers to secure a copy of the *Commercial* and study Mr. Sprague's masterly and exhaustive presentment of the case.

ELECTRIC "RAPID TRANSIT" FOR CHICAGO.

While New York has just fairly begun the earnest agitation of a better means of transit than is now available and has practically settled upon a plan involving some method of underground operation, Chicago has just begun a like agitation, in which, however, it has thus far confined itself to an elevated railway. In this respect it has the great advantage of the experience gained on the roads running in this city. If the plan to be adopted in Chicago offered no other improvement than the mere substitution of electricity for steam locomotives on the elevated road, that alone would be a powerful argument in favor of the adoption of the system. But the added advantages which the electric system will afford, such as the operation of single cars at high speeds, are such as will, we think, place it beyond the competition of any other method of propulsion. The plan proposed by Mr. Adams possesses several novel features and the electrical methods proposed, though not worked out to the last detail, present no difficulties with which the electrical engineer of to-day ought not to be able to cope successfully.

THE "CHEAP JOHN" IN ELECTRICAL WORK.

Probably no one has a better opportunity of knowing the character of the work as it exists to-day in electrical installations of every description than the insurance inspector, whose duty it is to examine carefully into the arrangements adopted, and to establish the premium rate accordingly. Hence the contribution to our columns from Mr. A. E. Braddell, the electrical inspector for the Middle Insurance Department, is of more than passing interest. It is, indeed, to be regretted that, as Mr. Braddell points out, cheap, *i. e.*, bad work still predominates. The reason for this it is not difficult to divine, when we consider the prevailing desire of most of us to obtain the greatest return from the least possible outlay. Not being able to distinguish between good and bad work, a private consumer is apt to put his work in the hands of men unfitted for it but whose prices may be somewhat lower than those of others competent to do it properly and honestly. Mr. Braddell, in analyzing the cause for this state of affairs, points out what has probably more than anything else contributed to bring about this deplorable state of affairs. This consists in the fact that in many cities, especially in small towns, the electric light companies do not themselves undertake or supervise the wiring of the premises of consumers, but simply furnish the current. The competition which is thus at once brought about between private concerns, added to frequent incompetency, is largely responsible, no doubt, for the present state of affairs. The central station, for its own credit, ought, if not directly engaged in the work of wiring, at least to supervise the wiring upon which its current is used, and the consumer ought not to be allowed to assume any risk. This would still leave the work open to competition, but under the restriction of competent superintendence by, what ought to be, a disinterested party. On the other hand, as has already been suggested, a system of examinations and licenses granted to those engaged in electrical installation work, such as that carried on by the New England Electric Exchange, would go far towards improving matters, for even if it did not improve the quality of the material employed, it would undoubtedly add to security by having the poorer material at least properly installed. We think the subject one which the National Electric Light Convention might very profitably take up and discuss at the Providence meeting.

100 Pages and Supplement.

The issue of The Electrical Engineer this week, barely ten months after its change from monthly to weekly publication, is one of 100 pages. There is also a Colored Supplement of wooden cleats for electrical purposes.

ELECTRICITY IN TRANSITU: FROM PLENUM TO VACUUM.

BY WM. CROOKES, F. R. S.

(*Concluded.*)

The next stage, dealing with more rarefied matter, is that of phosphorescence. Here is an egg-shaped bulb, shown in Fig. 19, containing some pure yttria, and a few rough rubies. The positive electrode, B, is on the bottom of the tube under the phosphorescent material; the negative, A, is on the upper part of the tube. See how well the rubies and yttria phosphoresce under molecular bombardment, at an internal pressure of 0.00068 mm., or 0.9 M.

A shadow of an object inside a bulb can also be projected on to the opposite wall of the bulb by means of an outside pole. A mica cross is supported in the middle of the bulb (Fig. 20), and on connecting a small silvered patch, A, on one side of the bulb with the negative pole of the induction coil, and putting the positive pole to another patch of silver, B, at the top, the opposite side of the bulb glows with a phosphorescent light, on which the black shadow of the cross seems sharply cut out. Here the internal pressure is 0.00068 mm., or 0.9 M.

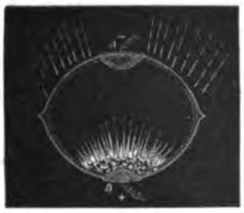

FIG. 19.—P = 0.00068 mm. = 0.9 M.

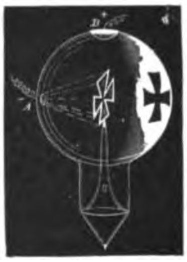

FIG. 20.—P = 0.00068 mm. = 0.9 M.

Passing to the next phenomenon, I proceed to show the production of mechanical energy in a tube without internal poles. It is shown in Fig. 21 (P = 0.001 mm., or 1.3 M.). It contains a light wheel of aluminum, carrying vanes of transparent mica, the poles, A, B, being in such a position outside that the molecular focus falls upon the vanes of one side only. The bulb is placed in the lantern, and the image is projected on the screen; if I now pass the current you see the wheel rotates rapidly, reversing in direction as I reverse the current.

Here is an apparatus, Fig. 22, which shows that the residual gaseous molecules when brought to a focus produce heat. It consists of a glass tube with a bulb blown at one end and a small bundle of carbon wool, C, fixed in the centre, and exhausted to a pressure of 0.000076 mm., or 0.1 M. The negative electrode, A, is formed by coating part of the outside of the bulb with silver, and it is in such a position that the focus of rays falls upon the carbon wool. The positive electrode, B, is an outer coating at the other end of the tube. I pass the current, and those who are close may see the bright sparks of carbon raised to incandescence by the impact of the molecular stream.

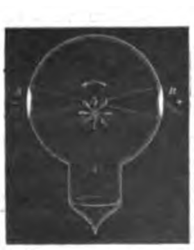

FIG 21.—P = 0.001 mm. = 1.3 M.

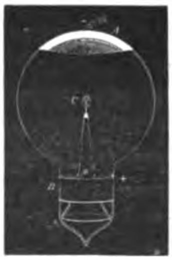

FIG. 22.—P = 0.000076 mm. = 0.1 M.

You thus have seen that all the old "radiant matter" effects can be produced in tubes containing no metallic electrodes to volatilise. It may be suggested that the sides of the tube in contact with the outside poles become electrodes in this case, and that particles of the glass itself may be torn off and projected across, and so produce the effects. This is a strong argument which fortunately can be tested by experiment. In the case of this tube, Fig. 23, P = 0.00068 mm., or 0.9 M., the bulb is made of lead glass phosphorescing blue under molecular bombardment. Inside the bulb, completely covering the part that would form the negative pole, A, I have painted a substantial coat of yttria, so as to interpose a layer of this earth between the glass and the inside of the tube. The negative and positive poles are silver discs on the outside of the bulb, A being the negative, and B the positive pole. If, therefore, particles are torn off and projected across the tube to cause phosphorescence, these particles will not be particles of glass, but of yttria, and the spot of phosphorescent light, C, on the opposite side of the bulb will not be the dull blue of lead glass, but the golden yellow of yttria. You see there is no such indication; the glass phosphoresces with its usual blue glow, and there is no evidence that a single particle of yttria is striking it.

PHOSPHORESCENCE IN HIGH VACUA.

Very many bodies, such as ruby, diamond, emerald, alumina, yttria, samaria, and a large class of earthy oxides and sulphides, phosphoresce in vacuum tubes when placed in the path of the stream of electrified molecules proceeding from the negative pole. The composition of the gaseous residue present does not affect phosphorescence; thus, the earth yttria phosphoresces well in the residual vacua of atmospheric air, of oxygen, nitrogen, carbonic anhydride, hydrogen, iodine, sulphur, and mercury.

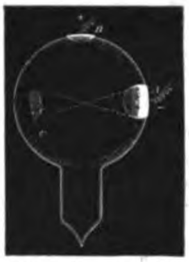

FIG. 23.—P = 0.00068 mm. = 0.9 M.

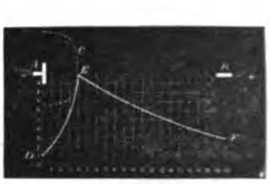

FIG. 24.—P = 0.25 mm. = 330.0 M.

With yttria in a vacuum tube, the point of maximum phosphorescence, as I have already pointed out, lies on the margin of the dark space. The diagram, Fig. 24, shows approximately the degree of phosphorescence in different parts of a tube at an internal pressure of 0.25 mm., or 330 M. On the top you see the positive and negative poles, A and B, the latter having the outline of the dark space shown by a dotted line, C. The curve, D. E. F., shows the relative intensities of the phosphorescence at different distances from the negative pole, and the position inside the dark space at which phosphorescence does not occur. The height of the curve represents the degree of phosphorescence. The most decisive effects of phosphorescence are reached by making the tube so large that the walls are outside the dark space, whilst the material submitted to experiment is placed just at the edge of the dark space.

Hitherto I have spoken only of phosphorescence of substances placed under the negative pole. But from numerous experiments I find that bodies will phosphoresce in actual contact with the negative pole.

This is only a temporary phenomenon, and ceases entirely when the exhaustion is pushed to a very high point. The experiment is one scarcely possible to exhibit to an audience, so I must content myself with describing it. A U-tube, shown in Fig. 25, has a flat aluminum pole, in the form of a disc, at each end, both coated with a paint of phosphorescent yttria. As the rarefaction approaches about 0.5 mm. the surface of the negative pole, A, becomes faintly phosphorescent. On continuing the exhaustion this luminosity rapidly diminishes, not only in intensity, but in extent, contracting more and more from the edge of the disc, until ultimately it is visible only as a bright spot in the centre.

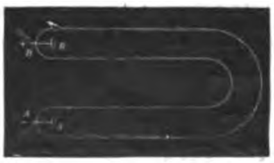

FIG. 25.

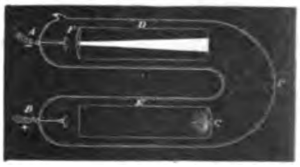

FIG. 26.—P = 0.000076 mm. = 0.1 M.

If the exhaustion is further pushed, then at the point where the surface of the negative pole ceases to be luminous, the material on the positive pole, B, commences to phosphoresce, increasing in intensity until the tube refuses to conduct, its greatest brilliancy being just short of this degree of exhaustion. The probable explanation is that the vagrant molecules I introduce in the next experiment, happening to come within the sphere of influence of the positive pole, rush violently to it and excite phosphorescence in the yttria, whilst losing their negative charge.

LOOSE AND ERRATIC MOLECULES.

I will now show you a piece of apparatus that clearly illustrates the cause of phosphorescence at the positive pole. A drawing of this tube is shown at Fig. 26. A C B is a U-shaped tube with terminals, A and B, at each end; D and E are two mica screens covered with a phosphorescent powder, having at F and G other screens with a small slit in front, so as to allow only a narrow beam of charged molecules to pass through. At first the tube is exhausted to a pressure of 0.076 mm. or 100 M., and you see how sharp and slightly divergent is the luminous image on screen D, whilst not a trace of phosphorescence is to be seen on the screen E in the other limb of the tube. Now I push the exhaustion to the highest point short of non-conduction (0.000076 mm., or 0.1 M.), and the phenomena change. The initial line of light on D becomes wider and unsteady, whilst at the gate, G, a decided phosphorescence is observable entering the second screen E. This luminosity diverges to a considerable extent, much more than did the stream of charged molecules observed in the first limb of the tube at the lower exhaustion.

THE RESISTANCE OF HIGH VACUA.

The passage of an induction current at a high vacuum through a tube depends much upon the material of the tube or the substance enclosed within it. Given the same degree of exhaustion, and the same distance between the terminals inside the tube, the E. M. F. necessary to force the current through may vary from 8,000 volts to 20,000 volts, according to the particular material used.

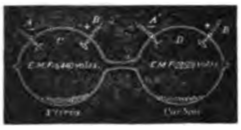

FIG. 27.—P = 0.02 mm. = 26 M.

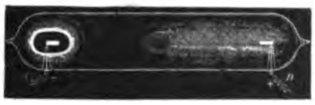

FIG. 28.

Here is a very striking example that will serve to illustrate this phenomenon. Fig. 27 is a double tube joined by a narrow open channel and therefore in the same state of exhaustion throughout (P = 0.02 mm. or 26 M). Each tube is furnished with a pair of poles, A, B, and A', B'. One tube contains the phosphorescent earth yttria, the other contains finely divided carbon. I first connect the yttria tube, C, to the coil, and place in parallel circuit with it a spark gauge. To begin with, this gauge is set to a gap of 1 mm. (An E. M. F. of 920 volts is necessary to strike across 1 mm. of air; therefore the difference of potential at the terminals inside the yttria tube is 920 volts, and this you perceive is not sufficient to force the current through the tube.) I now gradually open the gauge until the potential of the inner terminals has risen to a point high enough to allow the spark to pass through the tube, making the yttria phosphorescent.

The gap is at 7 mm., equal to an E. M. F. of 6,440 volts. I next attach the coil wires to the tube, D, containing the carbon, and the exhaustion in the tubes being the same as before, I repeat the experiment; you now see that the gap has to be opened to 30 mm., equivalent to an E. M. F. of 27,600 volts, before the current will pass through the tube. The fact of whether the vacuum tube contains yttria or carbon makes a difference of 21,160 volts in the E. M. F. required to cause a discharge between the terminals.

One other experiment I would like to show in further illustration of this resistance. The idea suggested itself that possibly differences in the material or conductivity of the particular bulbs might influence the results you have just seen. Here Fig. 28 is a long cylindrical tube of phosphorescent Bohemian glass containing a pair of terminals, A, B; it also contains a shorter cylinder of glass, C, C, brightly silvered inside. The internal pressure is 0.00068 mm., or 0.9 M. The silver cylinder is now at one end of the tube out of the way of the terminals, which therefore have phosphorescent glass around them. I turn on the coil and find that the E. M. F. necessary to force the current through, now that the terminals are in a phosphorescent chamber, is 1,380 volts. I slide the cylinder down to the end of the tube so as to inclose the terminals in a metallic silver chamber, and you see the E. M. F. necessary to pass the current rises to 6,440 volts. Metallic silver does not phosphoresce, whilst Bohemian glass phosphoresces very well. It appears that the greater the phosphorescing power of the substance surrounding the poles so much the easier does the induction spark pass. Surround the poles with Bohemian glass or yttria—two phosphorescent non-conductors of electricity—and the induction spark passes easily; immediately I surround the terminals with a non-phosphorescent conductor, the current refuses to pass.

WHAT OCCASIONS PHOSPHORESCENCE?

I should like to interest you in a question that has exercised my mind for some time past. What is it that occasions the phosphorescence of yttria and other bodies in vacuo under molecular bombardment?

So far I have found this phosphorescence to be an attribute of non-conductors only. We know that in the act of phosphorescence the molecules of yttria are in a state of intense vibration. Each molecule may be viewed as the radiating centre of the entire bundle of rays, which, when decomposed by the prism, displays a discontinuous spectrum. We may also suppose that the residual atoms of gas charged with negative electricity give off their electricity on coming in collision with a phosphorescent body and on their return take up a fresh charge.

THE ELECTROLYSIS HYPOTHESIS.

There is a certain amount of evidence in favor of an electrolytic hypothesis of the passage of electricity through rarefied gases. This has been ably advocated by Prof. Schuster in the Bakerian lecture before the Royal Society, March 20, 1890.

THE DARK SPACE IN MERCURY VAPOR.

In applying the electrolytic hypothesis, I have used for illustration's sake the gaseous residue of hydrogen, which is known as a diatomic gas. I have found, however, the phenomena of the dark space, etc., to occur in the vapor of mercury, which is a monatomic gas. This important result induced me to patiently investigate this subject, and the result of one experiment is before you, Fig. 29. The tube is furnished with aluminum terminals, and is so arranged that the induction spark can be kept passing during exhaustion to drive off occluded gases. When at the highest attainable vacuum, the tube is filled with pure mercury by simply raising a reservoir. On applying heat the entire contents of the tube are boiled away and pass down the fall tubes of the pump, exhaustion going on at the same time. When the whole of the mercury has thus been boiled away *in vacuo*, except a little, condensed at the upper part of the tube, the results on passing the spark are as follows: When the tube is cold the induction current refuses to pass; on gently heating with a gas burner the current passes and the dark space is distinctly visible. Continuing the heat so as to volatilise the drops of mercury condensed on the sides, the whole tube becomes filled with a green phosphorescent light, the dark space gets smaller and smaller, and ultimately the negative pole becomes covered with a luminous glow. On allowing the tube to cool, the same phenomena ensue in inverse order.

At first sight this result appears fatal to the electrolytic hypothesis, for if the molecule of mercury contains only one atom, how can we talk of its separation into positive and negative atoms by the electric stress? It must be remembered, however, that we are as yet ignorant of the absolute mass of the atom of any element. All that can be said is that a molecule of free hydrogen becomes halved in combining chemically with certain other elements, whilst a molecule of free mercury does not suffer division on yielding any known compound of mercury; the physical atoms in the one behave as two separate groups, and those in the other as one undivided group.

To show how intimately chemistry and electricity interlock, I may here remark that one of the latest theories in chemistry renders such a division of the molecule into groups of electro-positive and electro-negative atoms necessary for a consistent explanation of the genesis of the elements. This is so important that I may be excused for digressing a little into this development of theoretical chemistry.

FIG. 29.

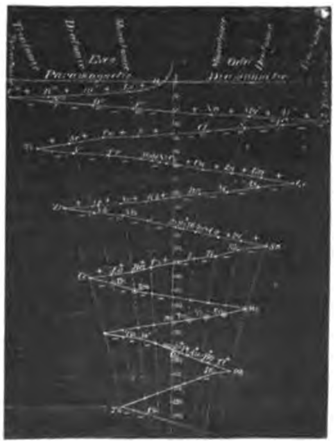

FIG. 30.

GENESIS OF THE ELEMENTS.

It is now generally acknowledged that besides the well-defined groups of chemical elements, there are underlying sub-groups. To these sub-groups has been given the name of meta-elements. The original genesis of atoms assumes the action of two forms of energy working in time and space—one operating uniformly in accordance with a continuous fall of temperature, and the other having periodic cycles of ebb and swell, and intimately connected with the energy of electricity (Fig. 30). The centre of this creative force in its journey through space scattered seed or sub-atoms that ultimately coalesced into the groupings known as chemical elements.

At this genetic stage the new born particles vibrating in all directions and with all velocities, the faster moving ones would still overtake the laggards, the slower would obstruct the quicker, and we should have groups formed in different parts of space. The constituents of each group whose form of energy governing atomic weight was not in accord with the mean rate of the bulk of the components of that group, would work to the outside and be thrown off to find other groups with which they were more in harmony. In time a condition of stability would be established, and we should have our present series of chemical elements, each with a definite atomic weight—definite on account of its being the average weight of an enormous number of sub-atoms or meta-elements, each very near to the mean. The atomic weight of mercury, for instance, is called 200, but the atom of mercury, as we know it, is assumed to be made up of an enormous number of sub-atoms, each of which may vary slightly round the mean number 200 as a centre.

This atomic scheme postulates a to and fro motion of a form of energy governing the electrical state of the atom. It is found that those elements generated as they approach the central position are electro-positive, and those on the retreat from this position are electro-negative. Moreover the degree of positiveness or negativeness depends on the distance of the element from the central line; hence calling the atom in the mean position electrically neutral, those sub-atoms which are on one side of the mean will be charged with positive-electricity, and those on the other side of the mean position will be charged with negative electricity, the whole atom being neutral.

This is not a mere hypothesis, but may take the rank of a theory. It has been experimentally verified as far as possible with so baffling an enigma. Long continued research in the laboratory has shown that in matter which has responded to every test of an element, there are minute shades of difference which have admitted of selection and resolution into meta-elements, having exactly the properties required by theory. The earth yttria, which has been of such value in these electrical researches as a test of negatively excited atoms, is of no less interest in chemistry, having been the first body in which the existence of this sub-group of meta-elements was demonstrated.

ELECTROSTATIC MEASURING INSTRUMENTS.[1]

THERE would seem to be some kind of prejudice against the use of electrostatic measuring instruments. Generally in an alternating current station, we find the high-pressure leads connected to transformers reducing to 100 volts or so, and a hot wire voltmeter employed to read by. The transformer takes, say, 30 watts, probably more, and the voltmeter another 30. This means 500 kilowatt hours per annum wasted. At 2½d. this comes to £5 a year, which is the interest on from £50 to £100. A laboratory electrometer was used in electric engineering by Joubert in 1881, and others have been used occasionally since by Professors Ayrton and Perry, Ryan and Monnier. Sir William Thomson has, however, introduced a number of electrostatic instruments, reading from 100 volts upwards, and engineers who use them do not revert to electro-magnetic or hot wire voltmeters. Electrostatic instruments not only take no power, but have no temperature errors, and do not need corrections for frequency, and no doubt they will eventually be cheaper than other forms. They cannot well be used as ammeters, but it is rumored—with what foundation we do not know—that Dr. Fleming will soon bring out an electrometer wattmeter. Of course, as shown by Professors Fitzgerald, Ayrton and Perry, a quadrant electrometer can be used to measure power, but unless the fall of potential over the shunt resistance in the current circuit is small, difficulties arise. Probably the electrostatic wattmeter of the future will have a split needle.

W. R. FLEMING & CO.

Messrs. W. R. Fleming & Co., selling agents for Harrisburg Ide and Ideal engines, boilers, etc., seem to be getting their full share of electric steam plant installation. Their claim to establish a leading business in these lines on reliable and conservative engineering work seems to be well founded.

During the past two weeks contracts have been made for the following plants: Messrs. Koch & Co., New York, one 90 h. p. and one 50 h. p. Ideal engine; Mt. St. Vincent, Central Park, one 20 h. p. Ideal; Heisler Electric Light Co., for town of Union, 200 h. p. Ide cross compound with boilers and complete steam plant; Pennsylvania Club House, Long Branch, 40 h. p. Ideal complete steam plant.

Several smaller orders taken make an aggregate of a trifle over 600 h. p. during two weeks.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER *150 Broadway, New York city.*

THE BERGMANN AMMETER.

On page 17 of your issue of Jan. 7, there appears a description of the new Bergmann ammeter. I take the liberty of drawing attention to the fact that I invented this type of ammeter as long ago as 1882 and patented it in Germany, the patent bearing the number 24,166, and the instrument being described in Figs. 6 and 7 therein.

F. UPPENBORN.

BERLIN, GERMANY.

THE MOST ECONOMICAL ARRANGEMENT FOR ELECTRO-DEPOSITION.

A few remarks from me upon Mr. Wilkes' "remarks" on my articles on Electro-deposition may possibly be of service in the cause of truth and justice.

I am sorry that Mr. Wilkes should have misunderstood my meaning when I said, "The polarization might also be expressed as a live or spurious resistance ρ, whose value is taken such that $C\rho = \varepsilon$." Perhaps he understood it to be a "dead", or ohmic resistance. Possibly he has never heard of the use of a fictitious (variable) resistance term, as an often convenient means to express loss of potential in circuits containing a counter electromotive force.

He does not think that the value of ρ could be separated from $(R+\rho)$. The relation $C\rho = \varepsilon$ points out a simple way by which it can be derived from his own method for obtaining ε. There it another simple way: from the potential difference at the terminals of the vat and the current passing through the vat, we obtain $\frac{E}{C} = R + \rho$. We then measure the ohmic resistance R, and subtract its value from $(R + \rho)$; or, $\frac{E}{C} - R = \rho$.

The product $C\rho$ gives ε as before. So far as practical accuracy is concerned this method will compare favorably with his method.

The equation in which ρ appears was only introduced as an alternative form. It is not numbered and is not again referred to at all in my articles. I can scarcely believe that Mr. Wilkes did not notice this; nor do I wish to suspect that he did not care to. However, he fails to do me the justice to admit that all the equations derived from (2) are unaffected in accuracy, and that the reasoning and conclusions hold good. As if to strengthen the impression conveyed, that my reasoning is all false, he proceeds to prove it again, by a method which differs slightly in detail from mine, principally because I wrote for the general reader and preferred to follow the longest, though most easy, "gradient" to the goal; I relied as much upon the logic of ideas expressed in words as upon that of ideas expressed in symbols, without any attempt at mathematical elegance or conciseness. I regret very much that Mr. Wilkes did not publish his demonstration *before* mine was published.

As to the value of n $(= 100)$ it was purposely taken large to make an extreme case and thus show more forcibly the relatively small increase in power as compared with one single vat. The term "actual data" refers, as might be inferred, to the values met in actual practice for polarization, resistance, current density, potential difference, etc., *per vat*. These data were, as a matter of fact, taken from plants working 85 to 70 vats. As for the comments on high voltage and current densities, I need only say that the articles treat of electro-deposition in general, and for all applications, of which refining is only one. My practical experience has embraced several of these applications, in some of which *speed*, in others, *economy* of deposition were prime considerations. The third article points out specifically that for refining, a low density is usually desirable and expedient.

The last "very prominent" point of dynamos referred to by Mr. Wilkes is almost humorous, considering that nine-tenths of the electro-deposition plants, even for refining purposes, use low potentials. The writer has himself used a dynamo giving 4,000 amperes at 10 volts. So far from "giving rise to no end of trouble," it never, so far as I now recall, gave any trouble whatever, during my experience with it of something like a year. It did not cost more than if wound for a higher E. M. F. Mr. Wilkes is evidently not aware, further, that the presumably oldest and largest electrolytic copper refining firm in this country has for years used, and so far as known, is still using, machines of over 4,000 amperes with an E. M. F. of 15 to 20 volts.

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[1] *Industries.*

I do not wish to advocate extremes, particularly, but merely to show what has been, and can be, done. The medium course between the two extremes is the plan I would doubtless follow in practice. The 36 kilowatt machine of Mr. Wilkes, if put in under my specifications, would probably be of 20 or 25 volts—not more than 30—even though it could not be found in stock. I would suit my own requirements, not the convenience of the manufacturer. The difference in cost is not worth discussing.

C. O. MAILLOUX.

NEW YORK, Feb. 13, 1891.

AN INVITATION FROM CANADA TO THE N. E. L. A.

The winter convention of the National Electric Light Association about to be held in Providence, R. I., presents a most opportune occasion to renew the suggestion I had the honor to make while attending a convention of the association during the past summer at Cape May, N. J., viz., that the next summer meeting of this electrical fraternity be held in Montreal, Canada. To more fully impress this idea, then so flatteringly received, on the members of the association, I seek permission to use the columns of your journal, as I feel no better medium exists, to reach the members, widely separated as they are throughout every State in the Union, than by means of the papers particularly devoted to electrical pursuits.

To do this thoroughly, in view of the vast benefits to be derived by such a gathering in Montreal, to the electrical interests of the Dominion, I may perhaps have to trespass too much on your valuable space. I remember, however, that your principal object is the dissemination of the knowledge of the powers of electricity, and think the points I wish to cover in carrying out my idea, are to the benefit of Canada, and the profit and pleasure of the members of the N. E. L. A. and will prove of interest to the general reader.

First, then, to be considered are the benefits to be derived by Canada in general, and Montreal in particular, by the holding of the Convention here. It is well known that every member of the association is one who, if not himself an electrician, has the advancement of the science, and all things thereto pertaining, at heart.

Canada, and this I can say from a personal knowledge, is as yet to a certain extent a *terra incognita* to the several branches of electricity and the various uses to which this subtile power is put in the United States. True, many, perhaps nearly all, of the cities of any importance in the Dominion, are lighted by the brilliant rays of the electric light, but it is equally true, as I found during my many visits to the most important towns and villages outside of the cities, that there are hundreds of the former, so to speak, in the dark, but ripe for the reception of this great conqueror of the nineteenth century.

A few of the cities have adopted a system of electrical street railways, now in course of construction, for trial, but I believe that its use for the transmission of power from central stations, for manufacturing and other purposes, has not even been attempted. Certainly the science on this side of "line forty-five," is as yet in its infancy. Here, then, is a wide field for the "National Association." In this "virgin soil," a world of good can be done by holding one of its meetings among us, by showing the strength of its organization, by showing its influence, and by the power it can wield by letting Canadians hear the learned discussions on the many highly interesting and widely practical papers on many things pertaining to electricity, read at these semi-annual re-unions.

Canadians are naturally a slow people in grasping at a project which they do not thoroughly understand, unless assured by personal experience of its absolute success; but once this is instilled into their minds, it will be found that they are blessed with as much push and energy as the most energetic people the world over.

How better then can they be taught to enter into and utilize the full usefulness of this grand power that science has placed at their disposal, than by seeing and listening to the men of brains, of wealth, and of influence that are banded together in this great brotherhood, "The National Electric Light Association of the United States."

Through my several years' experience in connection with the electrical business in almost every part of Canada, I can probably gauge the feelings of the general public on these matters as well, if not better, than most, and therefore I know the vast majority are in favor of electrical advancement. I know further that all that is requisite for the formation of a *Canadian Association* on similar lines, which would give rise to electrical experiments throughout the Dominion, and a "boom," is the coming of our anticipated visitors. In using the word anticipated, I do so advisedly, for since my return from Cape May, I have been indefatigable in telling our people of the distinguished guests, individually and collectively jolly good fellows, in addition to their scientific worth, whom we might expect next summer. All classes, including the most influential men of our population, have received the information with every expression of delight. An official civic reception even would be probable, which, if given, would equal, if not excel, that tendered the visiting Iron and Steel Institute last year. One thing is certain, however, that should these electrical magnates, or the "*magnets*," with their lady guests, come, as all hope, nothing in Montreal will be too good for them and they may rest assured of receiving a true Canadian welcome.

So far I have spoken of the benefits to accrue to Canada by the holding of the Convention in Montreal. I will now say, in a few words, why it would be advisable to do so.

First: Montreal is within easy reach of every point in the Eastern, Western and Northern states. If approached by rail, there are a dozen different routes centering here with their connections, the principal of which are the Grand Trunk with its Chicago and Western connection, the Canadian Pacific with its St. Paul and Minneapolis branch; also in the East with the Boston Air Line, the Central Vermont, connecting with the Boston and Maine Central and New York Central, and the Delaware connecting with the New York Central. Special reduced rates over these several routes no doubt could, and would, be arranged for the members of the association. All the lines named run through parts of Canada where the scenery is of great and varied beauty. If by water, via the St. Lawrence route, on which ply the palatial boats of the Richelieu and Ontario Navigation Company, and by which the greater part of the trip could be accomplished, the visitors would enjoy the novelty of a semi-ocean voyage by the turbid waters of the rapids, and could return by the more rapid railways. In all probability the larger number of the members would select the journey by water, as in doing so they would have the pleasure, spiced by an infinitesimal degree of danger, of "shooting the rapids" of the St. Lawrence, including the greatest of them all, the world famed one of Lachine. Before these would be reached, however, they would enjoy that grandest of all pieces of Canadian water scenery, a trip through nature's marine paradise, the Thousand Islands.

This route would also take the visitors over the Gallop, Coteau and Cascade Rapids, and through a variety of picturesque scenery.

But besides the pleasures of the St. Lawrence route and its famous Rapids, the trip will have even so far proved one of profit to the members of the association. It will by actual experience have given them some idea of the magnificent and almost totally unused water power of Canada. It will offer them food for reflection, and no doubt a worthy subject for subsequent discussion as to how this power could be best utilized as a motive force for electric lighting and other purposes to which electricity can be put. At present there is a somewhat, as yet, chimerical scheme afoot here to obtain the rights of the Lachine Rapids so as to utilize the current as motive power for many different purposes. The members of the association can visit the scene easily from Montreal, and decide how far the scheme is feasible.

One scheme of this great proposed undertaking proposes utilizing the power at "Isle-Aux-Herons," a small island directly at the foot of the Lachine rapids, which no doubt would be noticed by the excursionist to the north of the steamer as she wends her swift way to the city. This island has been divided by nature into two parts, and through the channel thus made runs a current of tremendous velocity. This island has been purchased by a strong syndicate, who propose to obtain one hundred thousand horse power or more, at this point, not alone by the facilities offered by the island, but by damming the north channel and thus obtaining the enormous energy of the rapids. This it is proposed to transmit by electricity to Montreal, four miles distant, for use there and in the surrounding districts. The only difficulty in the way of this is our annual Spring and Fall inundations, which, by the backing up of the water at the foot of the rapids, would materially affect this power. Able engineers are now at work trying to solve this difficulty, and strong hopes are entertained that it will soon be overcome; in fact, many experts favor a plan of flood prevention, which I have proposed myself and had under government consideration, and which the said experts claim would, by carrying off the surplus water of the ice-jammed river, answer every purpose.

No matter the way; let this difficulty once be surmounted, and Montreal and the surrounding country will have a motive power which will be one of the scientific wonders of the century, and which could never be obtained except through the power of electricity.

Then Montreal! As I have shown, the members will be received with open arms. There is no more beautiful city in America. Its manufactories, its public buildings, its historic relics, its scientific observatories, its magnificent churches, and last, but not least, the works for the manufacture of electrical apparatus, and the stations for lighting the city, are places of interest too numerous to mention in the space of a communication; but they are all worthy of visits, and will prove sources of pleasure and delight.

As to accommodation, the members of the association need have no cause to fear. Our hotels are among the finest in America, and the palatial Windsor, and the favorite St. Lawrence Hall have obtained a world-wide reputation.

There are many large halls, particularly that attached to the Windsor hotel, any one of which would be suitable for the business meetings of the convention, while there are equally commodious buildings suitable for the electrical exhibitions that are always held at these meetings of the association. On the occasion, which I hope will come, Canadian inventors and manufacturers in this line can exhibit side by side with those of the United States.

I think that above, I have given sufficient reasons why it will be in the interests of the association to hold its next Summer convention in this city, which is within easy reach of many other places of interest to the visitor, including Quebec, the Montmorency Falls, and such favorite resorts as Reviere du Loup, Murray Bay, Cacouna, etc.

Surely I have written enough to show that the association, so soon to be in conclave, should fix on Montreal as their next place of meeting; and why? Because I only voice the sentiment of Montreal's people when I say that it should be so.

In writing as I have, I did not wish to dwell too much on my country's merits, but simply to impress on these gentlemen, these Knights of Electrical Science, with ladies fair, the pleasures as well as scientific profit to be gained by holding the annual summer convention of 1891 of the National Electric Light Association of the United States in this city.

A word in closing, Mr. Editor, to the gentlemen of the association: Come one and all, and I can assure you once more a hearty welcome from the citizens of Canada and of Canada's metropolis! ALBERT J. CORRIVEAU.

MONTREAL, QUE., Feb. 3, 1891.

European Correspondence.

LONDON.

Paris Meter Competition.—Perreur Lloyd System in the Law-Courts.—Professor Ayrton on Disturbances.—Union of Munich and Berlin.—Acceleration.—Paris and London Telephone.—Electric Lock and Block System on the South London Railway.

IT is said that the Paris Electric Meter Commission has entered upon its duties of testing the seventy-one different kinds of meter sent in. The following is a list of the officiating judges: MM. Carpentier, Chretien, Hospitalier, Huet, Laffargue, Lemoine, Mascart, Meyer and Potier.

A fugitive system of generating electricity called the Perreur-Lloyd, which dazzled the vision of the City Commissioners here some time ago, has "o'er leaped itself" and fallen into the law courts. The Perreur-Lloyd system consisted in the erection of works for the manufacture of chemical products—sulphates, simple or double chlorides of copper, iron, zinc, manganese, nickel, etc.—in which electricity was considered only as a self-product. The claims were proved to be baseless. Notwithstanding, however, the condemnatory opinion of experts, an attempt was made to float a company for the purpose of foisting the rubbish on the English market. With this end in view, a Mr. Vesey induced two Yorkshiremen, on the plea that electricity could be produced for nothing, to place at his disposal £5,000. As no return was apparent, suspicions were aroused and an action was brought for the recovery of the amount. The jury entered a full verdict against the defendant.

Professor Ayrton in a letter to the *Times* discusses the probable effect of the proposed electric railway (subway) between Paddington and South Kensington on the laboratories of the Central Institution which are situated on the intended line of route. The Professor states that during the past few weeks Professor Rucker and himself have been taking measures to ascertain the magnitude of the disturbance that will be caused by the railway. They did not employ very delicate instruments, but the ordinary rough apparatus that is in daily use by students in a modern physical laboratory. This, however, was seriously affected by mechanical vibration, and they were led to the conclusion that the earth waves produced by the passage of large weights at high speeds impaired the measuring instruments. According also to the observations made, electrically propelled tramcars constantly passing within a few yards of the Physical Laboratory would make even rough electrical measurements absolutely impossible, and if the scheme is carried out it will entirely spoil one branch of the technical instruction which is now given.

The project of uniting Munich and Berlin by means of an underground cable was recently introduced in the Bavarian Legislature. All that is necessary is the laying of a cable to the Bavarian frontier town of Hof, where it would connect with the cable of Dresden, which is a continuation of the underground telegraph line from Berlin to Dresden.

In 1876 a test line was laid from Berlin to Halle, a distance of 169 kilometres. At the close of 1883, 30,000,000 marks had been expended in the development of an extensive underground telegraph network.

On the occasion of the forthcoming celebration of the German Emperor's birthday, there will be a display in Berlin of 25,000 electric glow lamps specially installed for outside illumination.

The cold weather has delayed the progress of the laying of the Paris–London telephone wire, in consequence of which, it will not be used until the first of March. The fifteenth of February is the date fixed for the submersion of the cable. The official's test will last until the end of the same month. The tariff has been fixed at 10 fr. for three minutes' use of the telephone. It is said that Queen Victoria and President Carnot will speak the first message.

Last Wednesday evening Mr. Spagnoletti, M. I. C. E., read a paper before the Inventors' Institute on the electric locking and block system as applied on the City & South London (Electric) Railway. Mr. Spagnoletti after a concise description of the construction of the line fully explained and described the working of the electric locking system as applied to both double and single lines. The lever of the starting signal is always kept locked to "danger," and before a signalman can possibly pull it over to lower the signal arm for a train to leave his station he must send a bell code to the next station in advance to unlock his lever.

This can only be done by the man at the station in advance sending a current of electricity by an instrument in his signal box, and the act of sending this current locks up his instrument, so that he cannot possibly send another until the train arrives at his station, and passes the clearing point, when it passes over a contact maker and resets his instrument, so that it can be worked again for a second train, but not until the first train has arrived and the section is clear. When the signal arm has been unlocked and lowered for a train to proceed, after its departure it must be replaced to danger, and it cannot be lowered a second time until the lever has again been unlocked from the station in advance and the station in advance cannot again unlock until the train occupying the section has cleared it, and reset his instrument to enable him to do so. This piece of automatic working which gives no signal itself, forms a thorough check upon the signalman and prevents him making any mistake from any misapprehensions he may have in his mind. It simply resets the instrument to enable him to work it again, and checks him if he should attempt to work it at a time when he ought not to do so before the section is clear. When the starting signal lever has been lowered for a train to leave, it must be put back again, or the signalman cannot take the lock off for a following train coming from the station in his rear.

In working single lines, when taking the lock off at either end from the opposite end of the single line section for a train to proceed, the act of releasing the lock at the other end, locks up the instrument and severs the wire which conveys the current to the lock in either direction, so that it is impossible to take the lock off again at either end until the train occupying the section has arrived at the proper place in whichever direction it is going, and resets the instrument and re-establishes the circuit.

When the lock has been taken off by the station in advance for a train to proceed over the section, and the train from any cause should not proceed, the signalman is compelled to move his lever and lock it before he can take the lock off at the other end for a train coming in the opposite direction.

Mr. Spagnoletti also pointed out that in working junctions one instrument only is required, as by means of a switch any number of line wires connecting the next stations on the various branches can be joined to this one instrument without affecting the safety of the working.

In crossing trains from one road to the other, he explained that when the levers affecting the cross-over roads were unlocked, trains could not be allowed to approach the station on either the up and down line and vice versa. He pointed out that a section might be divided into two sections and yet be worked by the same signalman, by having an intermediate signal locked from the same signal box, so that the one signalman could work both sections, first taking off the lock at the station in the rear for a train to proceed to the intermediate signal fixed at a certain point, which signal lever can only be unlocked by himself when the second section is clear, thus saving the expense of an extra signal station and staff to work it.

On local lines where trains stop at every station, there is no need for fogmen in foggy weather, because no train enters a section until it is quite clear, and the train itself controls the working of the section. Should any derangement occur to the instruments in the working, the safety of the system is not affected, neither is any delay to the traffic caused, because the derangement locks everything up on the side of safety, and the instrument can be moved by hand as well as by the treadle, under the guidance of the inspector or other authorized person, when any derangement may occur. This system does not relieve the signalman from any of his present responsibilities, it simply checks him from doing wrong if he should attempt to do so, and prevents him from working the signals when he should not do so. This system is at work on many lines and is giving every satisfaction.

It is a system which will no doubt grow as it becomes better known and understood, and it is one which evidently will very greatly add to the safety of railway working. Diagrams and working instruments were exhibited and explained.

H. B.

LONDON, Jan. 21, 1891.

Home Correspondence.

PITTSBURGH.

A New Mast Arm.—Electric Railway Notes.—Report of the Allegheny County Electric Light Co.

THE Allegheny Committee on Public Lighting has under consideration the advisability of adopting a newly patented mast arm for electric lighting of the streets. One of these mast arms is now being erected on trial. This arm is different from some of the others in that it does away with the necessity for climbing the pole, and when the lamp is lowered for cleaning and changing carbons there is no danger to passing teams. At the base of the pole is a locker, in which is the crank with which the lamp is lowered. This also provides a place for storing carbons and tools. The lamp when lowered is first drawn to the pole, then it comes down in a straight line. A man named Carlisle, who resides in Lawrenceville, this city, is the patentee of this mast and arm.

The Citizens' Traction Company, of this city, has just made a contract with a local electric light company, for the lighting of their power-house and the vaults of their cable road.

One of the Allegheny electric street railway lines suffered a few days ago from a landslide, which did considerable damage to the tracks of the line. The Bellevue Electric Railway runs for a distance along the brow of a hill. The recent excessive rains, however, caused the ground above the tracks to loosen and at last it gave way altogether. The land came down with great force, carrying quite a portion of the track in its path and leaving the rails suspended in the air. Fortunately, no car was passing there at the time. The damage to the track will be immediately repaired.

The annual meeting of the Allegheny County Electric Light Co. was held in the company's office in the Westinghouse building a few days ago, and the following board of directors was chosen: George Westinghouse, Jr., A. M. Byers, Robert Pitcairn, C. L. Magee, T. Sproull, Wm. Eberhardt, J. E. Ridall, G. H. Blaxter. Owing to the absence of Mr. Westinghouse, the organization of the board was deferred until his return from the East, where he now is in connection with the plan of placing 40,000 shares of preferred stock of the Westinghouse Electric and Manufacturing Company. The financial statement for the year 1890 was read to the meeting, containing the following interesting items: The earnings for the year were $310,256.24; operating expenses, $199,041.77; earnings over operating expenses, $111,214.47; less interest on bond and mortgages interest on discounts, $44,025.41; net earnings, $67,189.06. The comparative statement of electric lights operated by the company for the last four years is very interesting. It shows that in 1887 the number in use were 10,511; in 1888, 20,145; in 1889, 27,829; in 1890, 33,500. The number of arc lights operated by the company in 1890 amounted to 857. Since the first of December last, applications have been made to the company for the placing of 2,000 additional incandescent lamps.

PITTSBURGH, Feb. 13, 1891.

BOSTON.

Municipal Ownership of Lighting Plants.—An Underground Road.

THIS week the committee on manufactures continued the hearing on the question of municipal ownership of gas and electric light plants. Mr. Sylvester Baxter argued in favor of such control, claiming that private management tended towards concealing the profits, and imperfect lighting on moonlight nights, and after midnight, and that the business could be much more honestly managed under municipal control.

Mr. Baxter was cross examined by Mr. E. Burdett and Hon. P. A. Collins, who aimed to show that gas and electric light companies were conducting their business in the interests of the public.

In the common council the following orders were passed:

> That the mayor be requested to petition the General Court for such legislation as will authorize the city of Boston to construct and mantain such elevated railroads as the city council, with the approval of the mayor, may from time to time adjudge to be required for the convenience and necessities of the inhabitants of this city.
>
> That the mayor be requested to remonstrate against the granting, by the Central Court, of the petitions of any private persons or corporations for leave to locate elevated railroads in Boston, until the petition of the mayor, as above provided, is finally disposed of by the Legislature, or until authority has been granted to the city of Boston to exact compensation for the use of its streets by persons or corporations.

Boston is agitating an underground railway, and a hearing was given this week at the State House by the committee on street railways on the petition of Mr. H. C. Spaulding for permission to build subterranean railways in the counties of Suffolk and Middlesex. Mr. H. M. Whitney, in replying to Mr. Spaulding, maintained that if underground roads were built they should be constructed with reference to the surface roads, and that electricity should be the motive power.

BOSTON, Feb. 14, 1891.

CHICAGO.

Arc Lamp Litigation.—A Charter Revoked at Omaha.

THE contest over the electric arc lamp patent between the Brush Electric Company and the Western Electric Company is going on before Judges Gresham and Blodgett. Not long back the Brush Company secured an injunction restraining the Western Electric Company from infringing the patent. The Western Electric Company seeks a dissolution of the injunction on the ground that the Brush Company is interfering with a speedy trial in the United States Supreme Court. A counter motion is made by the Brush people to have the Western Electric Company attached for contempt of Court in violating the restraining order.

At Council Bluffs, Ia., a bitter fight has broken out between the city and the Omaha and Council Bluffs Bridge and Motor Company, of Nebraska. The above-named company some while ago absorbed all the street railway and motor lines of the city and operates now some 20 miles of lines of which about one-half is on paved streets. The company now in control absolutely refuses to pay grading and paving assessments and also refuses to pay property owners on streets where lines were laid after paving was completed. Last week the City Council passed an ordinance through under a suspension of the rules rescinding the charter, and later the city attorney commenced some half dozen suits against the company for various amounts for intersection, grading and paving.

CHICAGO, Feb. 12, 1891.

THOMSON SCIENTIFIC CLUB, LYNN, MASS.

The members of the Thomson Scientific Club were entertained at their last meeting, Feb. 5, by a very interesting talk on "The Copper Mines of Lake Superior" by Mr. C. H. Veeder, who spent about two years in that region.

The club is now settled in its new home in the two upper floors of the new building on the corner of South street and Western avenue, West Lynn, and within a few moments' walk from the Thomson-Houston Co. and Welding Co.'s factories.

The new quarters consist of a library, billiard and card room on the first floor, and a large well lighted hall on the second floor for lectures, besides committee room and janitor's quarters.

At a recent election, the following officers were elected for the ensuing year: President, J. E. Randall; 1st vice, J. B. Cahoon; 2nd vice, H. G. Reist; secretary, Franklin Sheble; treasurer, John B. Barr.

With an executive committee and sub-committees to regulate the various departments, the club has a very able list of officers, and although young, the Thomson Scientific Club is very prosperous and has a bright outlook.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of Feb. 18, 1891, from New York, Boston and Washington; Pittsburgh, Feb. 11.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	80¼	Edison Gen. Elec. Co.	102
American Tele. & Cable	83	Consol'd Elec. Lt. Co.	...
Centl. & So. Amer.	145	Edison Illn'g Co. N. Y.	79
Mexican	210	U. S. Elec. Lt. Co.	30
Com. Cable Co.	104	North Am. Phonograph	....
Postal Tel. Cable	39		

BOSTON.

	BID.		BID.
Thomson-Houston	*45	Ft. Wayne Co.	11⅛
" Pref'd.	25½	Am. Bell	191
" Series C.	....	" Rights	17½
" " D.	6½	Erie	*47
" Int. Co.	....	New England	50½
Thomson Welding Co.	....	Mexican	.65 cts
Thomson Eu. Welding	60	Trop. American	..
		Edison Phon'gph Doll.	....

WASHINGTON.

	BID.		BIr.
Penna. Telephone	25	U. S. Elec. Lt (Wash.)	140
Ches. & Pot. Telephone	56	Eck.&Sold. Home Elec. Ry.	56
Amer. Graphophone	8¼	Georgetown & Tenallytown	60

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co.	11⅝

* Ex-Dividend.

Reports of Companies.

ELECTIONS.

Lowell, Mass.—At the annual election of the Middlesex Electric Light Company, the following officers were elected: Clerk and treasurer, John H. McAlvin; directors, George W. Fifield, W. A. Ingham, John H. McAlvin, Louis I. Fletcher, Cyrus Conant, James H. Tolles and Charles S. Collins. At a subsequent meeting of the directors Mayor George W. Fifield was chosen president and W. A. Ingham, vice-president.

Lowville, N. Y.—At the annual meeting of the Lowville Electric Light and Power Company, the following officers were elected for the ensuing year: George D. Jackson, president; M. A. Stoddard, vice-president; John D. Moore, secretary and treasurer; R. P. Grant, G. M. Skinner, J. L. Bush, W. H. Morrison, John D. Moore, Morgan A. Stoddard, George D. Jackson, F. C. Schraub, directors.

Somerville, Mass.—At the annual meeting of the Somerville Electric Light Company, the following officers were elected for the ensuing year: H. C. Buck, clerk; F. S. Pearson, treasurer; directors, David Cummings, F. S. Pearson, J. Henry Fletcher, H. M. Moore, R. E. Nickerson, W. L. Hooper, L. E. Merry, and George B. Neal, treasurer of the Charlestown Gas Company. President Capen, who has been the president of the company since its organization, declined re-election as a director, as did also Dr. A. H. Carvill.

Detroit, Mich.—The Detroit Electric Light and Power Co. has re-elected its old officers and board of directors, with the addition of W. S. Crane and Ralph Phelps, Jr., as new directors.

Portland, Me.—At the adjourned annual meeting of the Consolidated Electric Light Company the old board of officers was re-elected with the exception of the clerk, Mr. Clarence Hale, who declined a re-election, and Mr. George E. Raymond was chosen in his place.

Newburyport, Mass.—The Newburyport Gas and Electric Company has elected the following officers for the ensuing year: President, E. F. Stone; directors, E. F. Stone, W. H. Swasey, Eben Sumner, L. B. Cushing, T. C. Simpson, William R. Johnston, Albert C. Titcomb; treasurer, D. D. Tilton; auditor, W. E. Chase. The usual semi-annual dividend of 3 per cent. was declared.

Northampton, Mass.—The Northampton Electric Company has elected the following officers for the ensuing year: President, A. McCallum; treasurer, C. H. Pierce; directors, S. B. Fuller, H. A. Kimball, A. McCallum, E. C. Davis, C. H. Pierce. A dividend of five per cent. was declared.

Seattle, Wash.—The stockholders of the Home Electric Company have elected the following trustees: Isaac Dobson, C. P. Stone, E. C. Kilbourne, Angus Mackintosh and D. B. Denton.

STOCKS AND BONDS.

Boston, Mass.—The United Electric Securities Co., A. A. Glasier, treasurer, has invited sealed proposals from the holders of its collateral trust sinking fund five per cent. bonds, first series, for the sale to the company of $100,000 of said bonds. The bonds were to be taken up last week and paid with accrued interest to February 16.

Bellevue, O.—It is proposed by Bellevue, O., to issue $20,000 worth of bonds for electric lighting.

DIVIDENDS.

Laramie, Wyo.—The Laramie Electric Light Company has issued its 4 per cent. dividend warrants for the half year.

The Holtzer-Cabot Electric Co., Boston, Mass., G. E. Cabot, treasurer, has declared a dividend of $4 per share, payable February 15.

Hartford, Conn.—The Hartford Electric Light Company has declared the usual semi-annual dividend of 3 per cent. payable on demand.

Peoria, Ill.—Henry Scearer, city electrician of Peoria, has been arrested for the robbery of a safe. The arrest has created surpise, as the prisoner has always borne an excellent name and has been high in official circles for years. He has confessed the crime and turned over $500 of stolen money. In cutting out a pane of glass in the rear of the building he broke his knife and cut his hand, then climbing in the window he dropped the knife and these clues led to his arrest. Scearer assigns his downfall to drinking and gambling.

Society and Club Notes.

INSPECTING THE BROOKLYN EDISON PLANT.

Nearly one hundred of the members of the department of electricity of the Brooklyn Institute responded to an invitation given by Superintendent William S. Barstow, of the Brooklyn Edison Illuminating Company, to visit the company's station at 360 Pearl street, on Feb. 7th. Among the number were several of the prominent electricians and mechanical engineers of Brooklyn. The party was divided into five sections, under the special care of Superintendent William S. Barstow, R. Lindsay, R. S. White, T. L. Clarke and J. L. Becker. A very enjoyable evening was spent.

RAPID TRANSIT AT THE NEW YORK ELECTRIC CLUB.

The next regular meeting of the Club will be held at the Club House on Thursday evening, February 26th. A dinner costing $3.00 per plate (exclusive of wine) will be served promptly at 6:30. The topic for discussion will be Rapid Transit for Cities. The Mayor of New York, members of the Rapid Transit Commission and a number of prominent men from various parts of the country actively interested in cable, steam, electric and horse street railway work, will be invited to be present as guests of the Club and participate.

Members desiring to be present at the dinner must notify the secretary, on or before February 23, in order that provision may be made for their comfort. As only about 100 can be seated at table, the custom of giving each member the privilege of inviting a guest will have to be suspended. Applications for the privilege may, however, be made to the secretary and will be granted in the order of their receipt by him, and as far as the Club's accommodation will permit.

At this meeting, in pursuance of a notice given at the last regular meeting of the Club, action will be taken on the following proposed amendment to the By-Laws:

"To add the following to Article IX to be called Section 2.

"Any By-Law may be suspended for a period not exceeding three months by a majority vote of the Active Members present at any regular meeting or adjournment thereof, or by a two-thirds vote of the Active Members present at any special meeting."

And in case the same should be acted upon favorably, a resolution will be submitted to suspend for three months that portion of the By-Laws which fixes the initiation fees for Active and Associate Members, and to admit new members during the same period on the payment of one-half of the regular initiation fee.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

A meeting of the Institute will be held on Feb. 24, at 8 p.m. at the house of the society, 12 West 31st street. Mr. Frank L. Pope will exhibit a most interesting electrical relic in the shape of one of the model electric railways made by Thomas Davenport, over fifty years ago. Mr. Pope will make a brief address on the subject. He will be followed by Mr. Oscar T. Crosby, who will read a paper entitled "Data and Results of Experiments with Electric Traction at 120 Miles an Hour," embodying his own experience and calculations in this novel department of applied electricity.

Legal Notes.

Saginaw, Mich.—Last May, the Michigan Central Railroad Company cut the overhead wires of the Electric Street Railroad Company on South Washington avenue, Saginaw. The street car people sued for $20,000 damages in the Circuit court, and were recently awarded $933.03 and costs.

THE ELECTRIC RAILWAY PLANT AT LOS ANGELES, CAL.

The Edison General Electric Company has sued the Electric Rapid Transit Company to recover possession of an electric plant used in the operation of a street railroad in Los Angeles, or for $50,000, its value, with $40,000 damages for its alleged unlawful detention.

Appointments, Etc.

Mr. Harvey D. Reynolds, for several years manager of the Buffalo business of the Postal Telegraph Company, has been appointed superintendent of the fifth division, including all the lines between Ogdensburg, Syracuse, and Cleveland.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEB. 10, 1891.

Accumulators :—

Electrode for Secondary Batteries, M. M. M. Slattery, 446,104. Filed April 6, 1889.

Claim 4 follows :

In a secondary battery, a porous copper electrode consisting of fine copper powder strongly compressed into a coherent body, an alkaline solution, and another electrode of zinc, iron, or other metal.

Alarms and Signals :—

Electro-Mechanical Indicator for Fire-Alarm Telegraphs, T. F. Gaynor, 445,991. Filed May 15, 1890.

Relates to indicators of the class in which a series of figured drums are actuated through electro-magnets and intermediate mechanism to display the requisite signals or indications.

Multiple Call-Box, F. B. Wood, 446,199. Filed Jan. 6, 1890.

A multiple call-box adapted to give, when operated, and without disturbing the central station instruments, an audible test signal to inform the person operating the box that the circuit over the line is complete, and adapted also to receive return-signals from the central station.

Fire Indicator and Extinguishing System, S. Broichgans, 446,200. Filed Oct. 29, 1890.

An apparatus, in connection with thermostats and automatic sprinklers, adapted to give an alarm locating a fire and indicating the turning on of water at the automatic sprinkler through an indicator at a central station or at the office of a building.

Conductors, Conduits and Insulators :—

Electric Insulator, J. R. Branch. 445,969. Filed May 20, 1890.

Designed particularly to prevent the impairment of insulation through the running of water down the insulator in wet weather. A section of insulating material to embrace the conductor, and adapted to be secured to the top of the insulator proper, is provided. The insulator has a flat base to be secured upon a support, is circular in cross section and is provided with a peripheral overhanging edge or drip.

Method of Laying Electric Cables, C. H. Wilson, 446,214. Filed Sept 19, 1889.

A device for adjusting a number of cables in position after they have been drawn into a conduit, and adapted to arrange them symmetrically and compactly. Consists substantially of blocks or wedges adapted to be drawn through a conduit to arrange the cables already drawn in and to clear a passage for the drawing in of additional cables.

Distribution :—

System of Electrical Distribution for Mines, E. A. Sperry, 446,080. Filed Apr. 1, 1889.

Claim 1 follows :

In a system of electrical distribution for mines, the main conductor leading down the main entries, branch conductors leading down the butt-entries derived from said main conductors, and ammeters located at the junctions thus formed, in combination with machines for both mining and transporting, deriving their energy from the same wires.

Automatic Potential Regulator for Electric Currents, A. L. Ellis, 446,284. Filed July 3, 1890.

Consists in the combination with a potential-regulating device, of a pair of electric motors connected with the potential-controlling devices and with the main circuit, and a circuit-controlling magnet and armature arranged to send the current to one or the other of the motors, and so operating the potential-controlling devices according to the requirements of the circuits.

Dynamos and Motors :—

Dynamo-Electric Machine and Electric Motor, E. K. Brown, 446,092. Filed Nov. 1, 1889.

Relates to the design and construction of field magnets and pole-pieces and particulary to those that are laminated.

Regulator for Electric Motors, L. S. Harris, 446,229. Filed Aug. 30, 1890.

For the regulation of constant potential motors. Has field magnets wound with a shunt-circuit and armature wound with another shunt-circuit ; has also independent circuits in parallel-arc, of different sizes and lengths of wire, passing over the field-magnets and directing their current thence over the armature circuit, with switch mechanism for bringing the latter shunt-circuits successively into, and out of, action.

Lamps and Appurtenances :—

Extensible Bracket for Electric Lamps, J. E. Titus, 446,087. Filed Mar. 14, 1890.

Design and construction for a drop-light chandelier.

Electric-Arc Lamp, R. H. Mather, 446,108. Filed Jan 24, 1887.

A focussing arc lamp. In connection with two carbon-carrying slides employs a reversible electric motor, intermediate converting mechanism whereby the motor engages the slides, a three point pole changer controlling the motor and having two helices located in shunt-circuit about the carbons, and a lifting-magnet provided with a circuit-breaking mechanism applied to one of the shunt circuit.

Arc Light, R. H. Mather, 446,109. Filed Oct. 11, 1886.

Similar in scope to No. 446,108 above.

Electric Signal and Search-Light Lantern, G. W. Martin, 446,142. Filed Feb. 28, 1890.

Details of lantern for reflecting and directing the light of an incandescent lamp.

Insulating Coupling-Block and Cut-Out, S. Bergmann and C. J. Klein, 446,180. Filed Mar. 11, 1890.

A combined coupling-block and cut-out adapted to connect an electric light fixture to a gas pipe.

Electric-Arc Lamp, C. J. Schwarze, 446,297. Filed Oct. 2, 1890.

A focussing arc lamp.

Arc-Light System, C. J. Schwarze, 446,298. Filed Oct. 9, 1890.

A system of circuits for arc-lights in series.

Miscellaneous :—

Electric Switch, E. A. Sperry, 416.081. Filed July 2, 1890.

A double circuit-closer and breaker actuated by a rotating cam.

Lightning-rod, G. W. Downey, 446,130. Filed Oct. 15, 1890.

Comprises a strip of sheet copper angularly bent and twisted into spiral form.

Electric Cooking Apparatus, J. O'Meara, 446,174. Filed May 1, 1890.

Surrounds an enameled cooking vessel with coils of German silver or other wire and surrounds the wire with an insulating covering.

Automatic Weighing-Scale and Indicator, A. B. Rover, 446,208. Filed Sept 27, 1890.

Electro-magnetic apparatus employed for arresting the traveling poise and indicating the figures of the scale.

Heat-Regulating Apparatus, G. L. Shorey, 446,212. Filed Apr. 28, 1890.

A combination of fluid-pressure and electro-magnetic apparatus with a thermostat for heat regulation.

Railways and Appliances :—

Switch and Signal Apparatus, G. Westinghouse, Jr., & J. G. Schreuder, 446,159. Filed March 19, 1888.

Relates to interlocking mechanism for controlling by fluid pressure and electro-pneumatic pressure, appliances for moving switches, signals or other similar devices at a distance, where a return indication of completion of the movement is desired, and where the completion of such movement effects a locking of the controlling magnet.

Electric Locomotive, G. R. Baldwin, 446,245. Filed July 17, 1890.

Relates to mounting of motors on electric car trucks and gearing them to the driving axles. Armature shaft is longitudinal with the car truck, its pinion driving a gear wheel upon a central shaft extending to both axles and connected to them by beveled gears.

Electric Signal System for Railroads, E. C. Wiley, 446,318. Filed Nov. 13, 1890.

A track circuit-closer to be actuated by passing trains.

Electric Railway and Contact Device Therefor, E. M. Bentley, 446,376. Filed Sept. 20, 1888.

Details of contact-device for conduit electric railway system. The contact is substantially a two wheeled trolley.

Track Instrument for Railway-Signals, M. S. Conly, 446,403. Filed June 5, 1890.

A track-instrument to be actuated by passing trains and adapted to either open-circuit or closed-circuit signals.

Telephones and Apparatus :—

Telephone Transmission, J. W. McDonough, 446,188. Filed Aug. 28, 1885.

Substitutes for the induction coil usually employed, a dynamo the field-coils of which are connected with a michrophone transmitter and a suitable source of electricity ; the armature, revolved by any suitable power, is connected in line with the receiver.

Claim 1 follows :

The herein-described method of transmitting sounds electrically consisting in producing changes in the intensity of a magnetic-field corresponding to the character of the sound vibrations, revolving a magneto-electric armature in said field by any suitable power, and delivering the variable currents as produced to a suitable receiving instrument.

Personal.

GEORGE W. STOCKLY.

The recent sale and transfer of the business interests of the Brush Electric Co. has afforded a much desired opportunity for some of the officers who have been connected with it from the beginning to enjoy a well-deserved vacation. No small share of the brilliant success which has been achieved by this company is due to the enterprise and sagacity of its managers, and especially of its retiring president and business manager, Mr. G. W. Stockly.

Mr. Stockly is a native of Cleveland, Ohio, and studied for the legal profession, but was forced by circumstances into the vocations of commerce and banking. In 1873 he became financially interested in the Cleveland Telegraph Supply and Manufacturing Co., and subsequently, by the death of his associates, the entire management of the concern unexpectedly devolved upon Mr. Stockly. Although possessing at that time scarcely any technical knowledge of the electrical business, he proved himself equal to the emergency. In a very short time he made himself master of the situation, and the business of the company prospered accordingly. In 1876, a chance conversation between Mr. Stockly and Mr. Brush in reference to the Gramme and other dynamos, led to an expression of opinion by Brush that much more efficient machines might be made. This idea was eagerly taken up by Stockly, who offered the facilities of his factory and selling organization for securing the introduction and sale of such a machine, if it could be made. This led to the development of the celebrated Brush dynamo and Brush arc lamp, and under Mr. Stockly's energetic management the business ultimately grew to enormous proportions. In 1878 the total sales of the company were less than $50,000. By 1883, they had increased to $2,000,000. In 1880, the company was reorganized under the name of the Brush Electric Co., and since that time, its record has been that of continuous and unbroken success. It is understood that the purchase by the Thomson-Houston Co. was made on a basis of over $3,000,000 for the capital stock of the Brush Company.

Mr. Stockly is to be congratulated upon the wisdom of his decision to withdraw, at least for a time, from active business pursuits, and to enjoy the leisure which he has so well earned. He is now living in a retired but beautiful place at Lakewood, N. J., but no doubt still finds something to interest him in the successive movements upon the electrical chess board. There are few men to whom the electrical industries of the present day are more indebted than to Mr. Stockly, and the good wishes of all will follow him in his retirement from the arduous post of duty which he has held so long and so successfully.

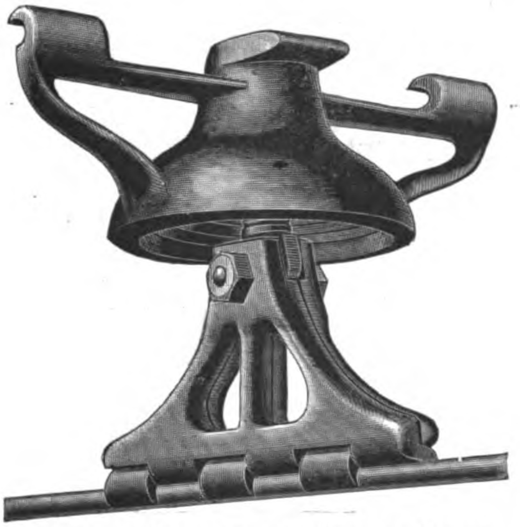
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Conventions come and conventions go, but an 'ad.' talks on forever."

A NEW TROLLEY WIRE HANGER.

We show in the accompanying engraving a purely mechanical device for hanging trolley lines, designed to facilitate overhead construction, and to make it possible to adjust the hanger easily to any stretching or contraction of the trolley wire. By the use of this hanger one man can shift several miles of hangers in ten hours. As will be seen in the cut, the device, though it can be so readily applied and removed, offers a firm support to the wire, as by tightening the bolt at the top, the grip of the tongs can be made very great. The clamp screws into plates imbedded in vulcanized rubber, which forms the insulating medium, and which is protected by a metallic shell. The hanger is attached to the span wire in the manner now in common use, which has proven so satisfactory. It is one of the new articles brought out by the Electrical Supply Co., of Chicago.



"Hercules" Hanger for Trolley Wires.

THE "A. B. C." INCANDESCENT LAMP.

It is rare that a new invention, or an improvement on an old invention, becomes so favorably known and so generally adopted as has the "A. B. C." incandescent lamp. Prior to the autumn of 1890 there was no "A. B. C." lamp, though its sponsors were well and favorably known. Within a period of four months the "A. B. C." lamp has been adopted by many of the largest central stations throughout the country; it is shining in the streets of the principal cities, in the mills and factories of New England, the Middle States, the South and the West, and in the large office buildings whose tenants enjoy the advantages of electrical illumination.

The "A. B. C." Incandescent Lamp.

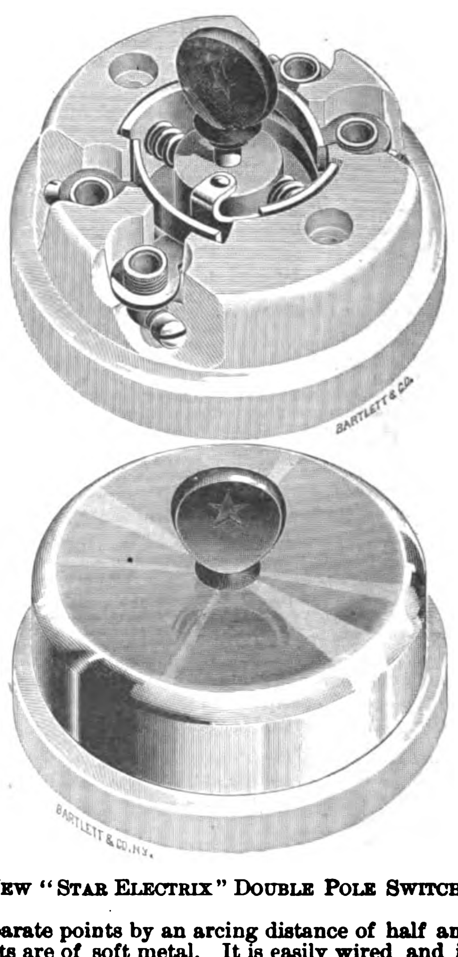
This lamp, a cut of which is shown, differs from others principally in the formation of the carbon filament, the sealing of the filament to the platinum wires, and the exhaustion of the glass bulb. The care that is taken in these three processes, and the attention given to minute details which might have a bearing on the efficiency and life of the lamp, is such as can hardly fail to produce a superior article. In addition the manufacturers pride themselves on the mechanical excellence of their lamp; ill-fitting bases and bulbs, spotted and fire cracked glassware, poor connections, bad sealing and other defects reflecting on the methods of manufacture are entirely absent. Certainly no more symmetrical and well finished lamp has been seen, and the South Boston factory deserves to be congratulated on the result of its labors.

The lamp is at present made in all voltages and to fit all sockets, and in candle-powers ranging from 8 to 50. The manufacture of other sizes may be taken up as soon as shorter nights, and the correspondingly less need of illumination, brings about a possible decrease of orders.

Alexander, Barney & Chapin carry a large stock of the lamps at their New York warerooms, 20 Cortlandt street, and are consequently able to ship from there and from South Boston with equal facility.

NEW STAR ELECTRIX DOUBLE POLE SWITCH.

We illustrate, in the accompanying engravings, a new double-pole switch which is just being brought out by the Star Electrix Co., of Philadelphia. The circuit in this switch is made and broken at four separate points by an arcing distance of half an inch. All the contacts are of soft metal. It is easily wired and is claimed to be the smallest switch of its capacity made.


BARTLETT & CO.
BARTLETT & CO. N.Y.

New "Star Electrix" Double Pole Switch.

NEW YORK INSULATED WIRE CO.

One of the most prosperous and progressive of the wire concerns is that above named, of 649 and 651 Broadway. Its products are well known, widely used, and have secured a most enviable popularity and reputation. So incessant and intense has been the work in connection with the growth of the business that Mr. R. E. Gallaher, the secretary and treasurer, has recently been compelled to seek rest and recreation in the South. He has returned to his labors much the better for the change, ready to give Mr. J. W. Godfrey, the general manager, some relief. Mr. Godfrey will represent the company at the Providence Convention.

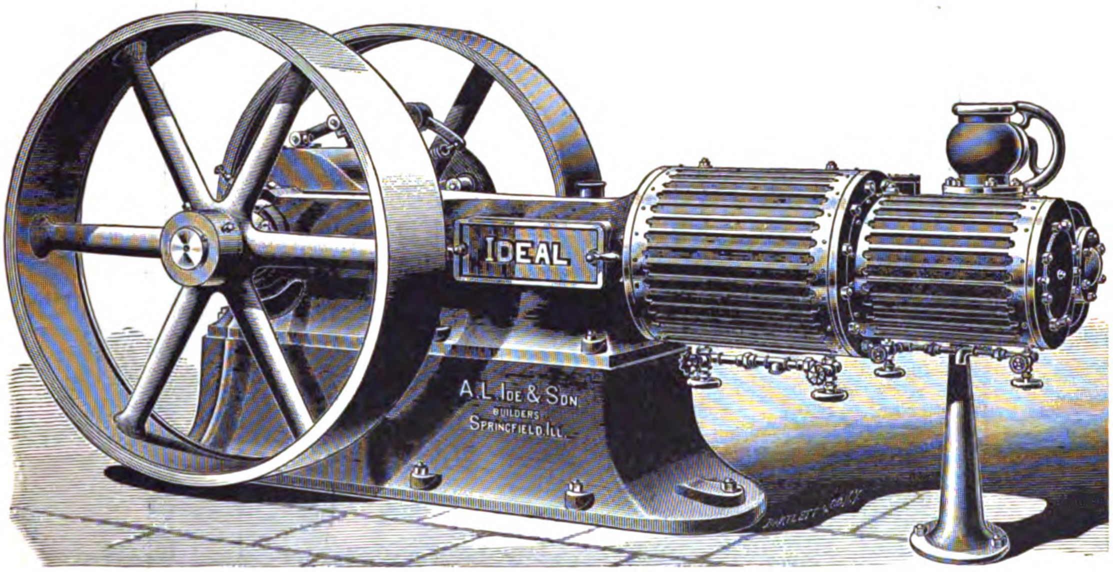
THE "IDEAL" COMPOUND ENGINE.

In designing their tandem compound engine, Messrs. A. L. Ide & Son have endeavored to produce an engine giving the highest economy in the use of steam and meeting all requirements in generating electricity; in short, a reliable, simple engine of great strength and durability. The result of their efforts is, therefore, called the "Ideal" engine, which is shown in the accompanying illustration.

The frame is heavy and self contained, with overhanging wheels, the bearings are all self-oiling, with the working parts enclosed, which reduces the wear, prevents hot bearings and effects a great saving of oil and attendance.

The cylinders are arranged on the well-known tandem plan, and are so proportioned as to give the highest efficiency. The high pressure cylinder is cast on the head of the low pressure, which, in its turn, is bolted directly to the engine bed. By this arrangement the steam has a short, direct passage from one cylinder to the other, without suffering loss of heat, by passing through connecting pipes or receiver. In addition to this advantage, four stuffing boxes are dispensed with, thus reducing the friction and the area of radiating surface. The head between cylinders is cored out, leaving a large space which is filled with non-conducting material, as is also the air space between the cylinders and jackets.

Both valves of this engine are controlled by the governor, they are on the same stem, moving together, and varying in stroke as the load and steam pressure varies, thus giving the advantage of automatic cut-off in both cylinders.



THE "IDEAL" TANDEM COMPOUND ENGINE.

The high pressure cylinder has a piston valve, double ported in order to give larger areas for free admission of steam. The low pressure cylinder has a flat balanced valve, traveling under a cover and supported on hardened steel rollers, and is so arranged that steam is admitted through three ports, giving a quick and wide opening at the beginning of the stroke, in order to reduce the pressure on exhaust end of high pressure piston.

These engines are shipped on heavy iron foundation bases, with driving wheels on, and are ready for immediate use, without the services of an expert, in setting or starting.

QUEEN & CO.

Queen & Co., of Philadelphia, inform us that their exhibit at the Providence meeting of the National Electric Light Association promises to be most interesting. They will show a full line of their special instruments and also a series of their new "Magnetic Vane" ammeters, which are specially intended for central station use. Regarding these ammeters, the Brush Electric Co., of New York, say in a recent letter: "We very cheerfully state that your ammeters as used by us have worked accurately and given most excellent satisfaction."

Queen & Co. have just completed negotiations with Profs. Bristol and Geyer, of Hoboken, N. J., for the control of their patent which covers a new form of recording ammeter. These instruments are not yet perfected, but they promise well, and there is certainly a great demand for a reliable recording meter.

E. G. Willyoung expects to look after the interests of the firm at Providence, and will be much pleased to receive a call from those in attendance and their friends. The exhibit will be in a most prominent position.

MR. W. C. BEHRENS.

With the intention of again devoting his whole time to patent practice, especially in the electrical field, Mr. W. C. Behrens has opened an office at 120 Broadway, where he is prepared to take up patent work and patent causes. He is peculiarly qualified for work of this character, from the fact that he has had quite an active and successful participation in mechanical and electrical manufacturing. It is also a fact not generally known, so fast is the pace in these rushing days, that, as secretary of one of the earliest commissions in the country to investigate the problem of underground wires, his report, presented some seven or eight years ago, is one of the first and most interesting documents on the subject. Mr. Behrens is, in fact, well informed on the electrical art in all its ramifications.

THE EASTERN TELEGRAPH CO., LIMITED.

We have received a copy of the very neat diary for 1891 issued by the above cable company. It is intended primarily for use in England and the Colonies, but abounds in information useful anywhere. At the end of the book are a number of very well executed maps showing the vast reach of the company and its allies in the submarine cable field. The company's headquarters in this city are at 40 Broadway.

J. H. SIEGRIST, JR., & CO.

Messrs. J. H. Siegrist, Jr., & Co, 313 Olive street, St. Louis, Mo., have just furnished the St. Louis Railroad Co. with two "Ideal" engines for the electric light plants in the north and south power houses of that road. They are also erecting "Ideal" engines for the Cox & Gordon Pork Packing Co., and the Illinois Glass Co., Alton, Ill. These engines are self-lubricating throughout, and in place of ten or twelve small oil cups found on most engines, each of which must be carefully watched to keep the oil feeding drop by drop, these engines have but one oil receptacle, from which the oil is automatically delivered in streams to all parts of the engines requiring lubrication. The oil then returns to the oil chamber to be used again. These engines are built in all sizes especially for electric lighting and railway plants.

RAWHIDE PINIONS ON ELECTRIC CRANES.

The following letter has been received by the New Process Rawhide Co., of Syracuse, N. Y.:—

MILWAUKEE, WIS., Jan. 9th, 1891.

Gentlemen: —We have had some of your Rawhide Pinions in use for the past eight months, doing very heavy duty, and find that they show very little wear; while we have used them they have been perfectly satisfactory, and judging from our present experience, we do not know of anything equal to them in situations in which quiet running at high speed is desirable.

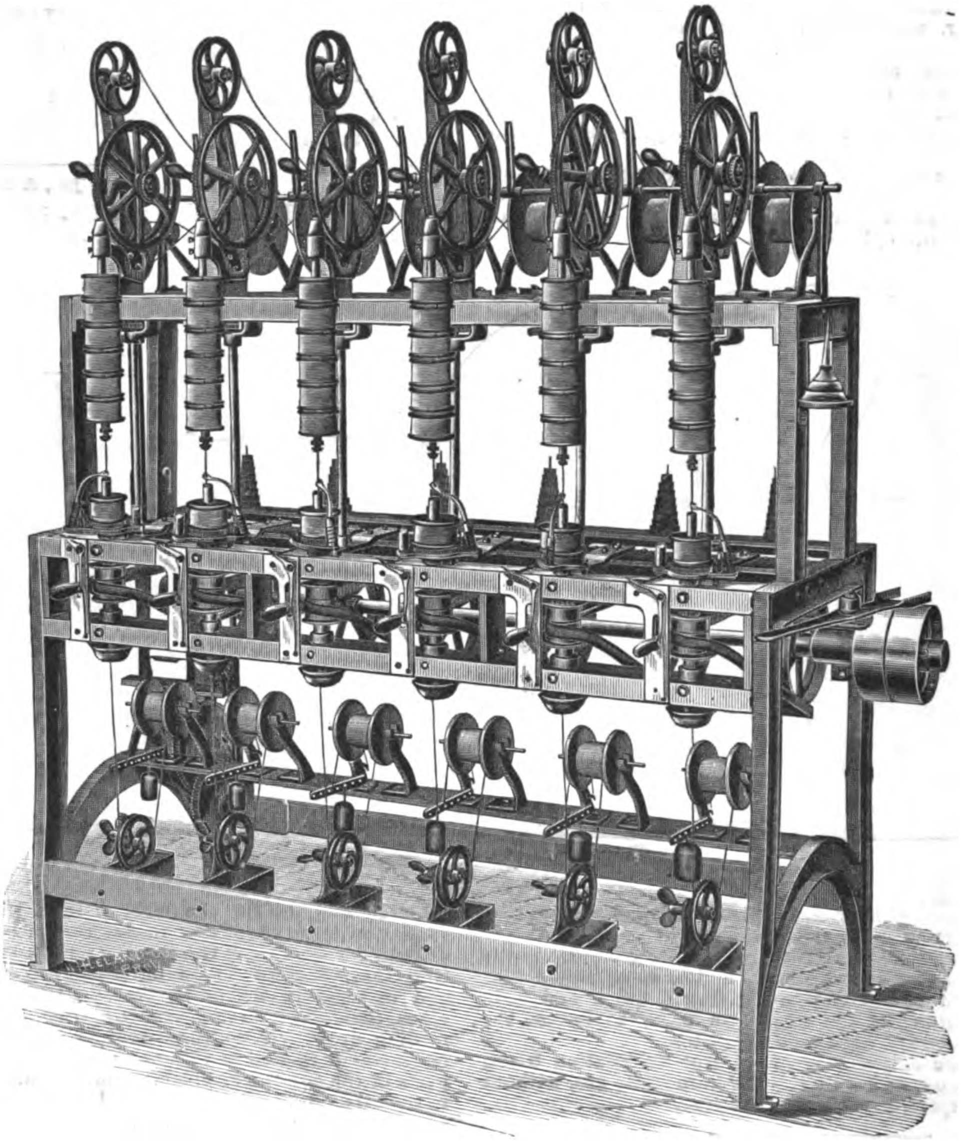
Very truly yours,
[Signed] THE SHAW ELECTRIC CRANE CO.
A. P. SHAW, Supt.

DETROIT, MICH.—The Detroit Electric Power Co. has filed amended articles of incorporation, increasing the number of directors from seven to nine.

A NEW WIRE INSULATING MACHINE.

THE accompanying illustration represents a machine manufactured by the New England Butt Company, of Providence, R. I., for covering the finer numbers of electric wires with silk or cotton, and which embraces some new and ingenious features.

The construction of the machine is such as to secure the maximum speed consistent with perfect work. The winding point has a fine adjustment for tension, and for the different sizes of wires, and the spool being on the spindle admits of high speed. A novel feature is the reserve supply of full spools of silk or cotton, which take the place of those from which the thread has run out, the change being made without cutting the wire. Each spindle is independent, so that different sizes of wires can be wound at the same time, and each has an attachment by which, if a thread breaks or a spool becomes empty, the machine is stopped. A simple and quick arrangement is also provided for changing the speed of the take-up wheel, and for turning back to splice a broken wire. When covered, the wire is wound on a reel at the back, where it is laid smoothly by means of a traverse motion.



THE NEW ENGLAND BUTT CO.'S NEW WIRE INSULATING MACHINE.

This machine has already attracted considerable attention in this country and orders are now being filled for England and Spain.

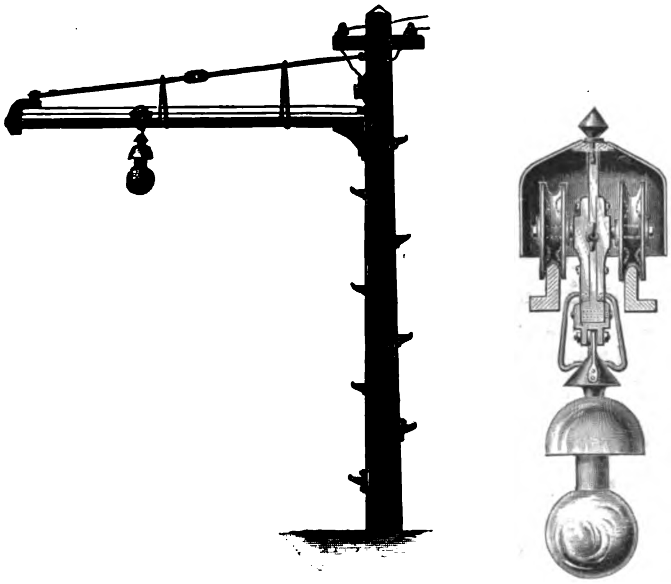
THE ST. LOUIS CAR CO. are building electric cars for Kansas City, Fort Scott, Kan., Waco, Tex., Dallas, Tex., San Antonio, Tex., Springfield, Mo., Memphis, Tenn., Ogden, Utah., Butte City, Montana, Pittsburg, Kan., Lasalle, Ill., The Davenport and Rock Island Consolidated Street Railway; also vestibule cars for Indianapolis, Ind. They are also buildiug 12 snow sweepers, each of which is fitted with three motors, the third motor being used to drive the sweeping device.

THE NATIONAL PIPE BENDING CO.

The National Pipe Bending Co., New Haven, Ct., manufacturers of the National feed-water heater, report a large increase in their business of the last three months over that of the previous year. During this time they have sold one hundred and ninety-four heaters, including:—One 300 h. p. to Washington, Pa.; 200 h.p. to Rosendale, N. Y.; 100 h. p. to Providence, R. I.; 100 h. p. to Middlebury Electric Light Co.; 1,000 h. p. to Lowell Electric Light Co., Lowell, Mass.; 100 h. p. to Denver, Colo.; 500 h. p. to New York City; 200 h.p. to Danbury, Ct.; 150 h. p. to Greenwich, Ct.; 200 h. p. to Elmira, N. Y.; 400 h. p. to St. Johns City Railway Co., St. John, N. B.; 100 h. p. to Aviles, Spain; 500 h. p. to West End Street Railway, Boston, Mass.; 300 h. p. to Wallingford, Ct.; 100 h. p. to Butte, Mont.; 100 h. p. to Jamaica, L. I.; 900 h. p. to Thomson-Houston Electric Light Co., Omaha, Neb.; 200 h. p. Newburyport Electric Light and Power Co., Newburyport, Mass.; 100 h. p. Brooklyn, N. Y.; 150 h. p. to Baltimore, Md.; 500 h. p. to Tyrone, Pa.; 300 h. p. to Brush Electric Light and Power Co., Savannah, Ga.; 50 h. p. to Ghent, Belgium; 200 h. p. to Montreal, Canada; 800 h. p. to East River Electric Light Co., N. Y. City; 100 h. p. to Killingly, Ct.; 150 h. p. to Eastchester Electric Light Co., Mt. Vernon, N. Y.; 200 h. p. to Providence, R. I.; 125 h. p. to Burlington, N. C.; 500 h. p. to South Philadelphia, Pa.; 100 h. p. to Edison Illuminating Co., Hackensack, N. J.; 800 h. p. to Johnson City, Tenn.; 300 h. p. to Morgantown, W. Va.; 300 h. p. to Summerfield Pa.; 300 h. p. to State Line, Pa.; 300 h. p. to Knepper, Pa.; 100 h. p. to New York City; 300 h. p. to Newark, N. J.; 150 h. p. to Marquette, Mich.; 100 h. p. to Indianapolis, Ind.: 150 h. p. to Greenwich, Ct.; 500 h. p. to Edison Illuminating Co., Newport, R. I.; 100 h. p. to Pittsburgh, Pa.; 400 h. p. to Weymouth Electric Light Co., East Weymouth, Mass.; 150 h. p. to Brantford, Ct.; 300 h. p. to Wallingford Ct.; 200 h. p. to Van Ness, N. Y.; 500 h. p. to Memphis Electric Light and Power Co., Memphis, Tenn.; 100 h. p. to Birmingham, Ct.; 125 h. p. to Cambridgeport, Mass.; 150 h. p. to Wilmington, N. C.; 300 h. p. to Terryville, Ct.; 1,200 h. p. to New Bedford, Mass. This company has also placed a large number of small heaters in isolated plants, particularly in manufactories and large buildings.

ELECTRIC LIGHTING SPECIALTIES OF E. M. CARHART & CO.

A number of inventions and improvements for electric lighting purposes have recently been devised by Mr. Van A. Thomas, superintendent of the Narragansett Electric Lighting Co., of Providence, R. I., some of which we illustrate in the accompanying drawings, as manufactured by E. M. Carhart & Co., of Providence, R. I.



FIGS. 1 AND 2.—MAST ARM.

The mast arm, shown in Fig. 1, is simple, strong and durable, made of two pieces of L iron, which are used as conductors as well as for the track to carry the lamp out over the street. These tracks with the supporting brace, are insulated from the pole, dispensing with the cable, which has always been a source of annoyance, as well as incurring continual expense. A switch is placed on the pole to switch out the lamp circuit while the lamp is being trimmed. Fig. 2 shows a section of the arm.

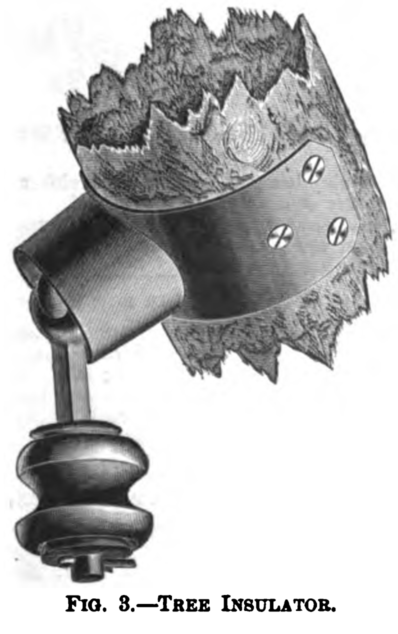


FIG. 3.—TREE INSULATOR.

By the use of the tree insulator, shown in Fig. 3, the line is kept in a normal position, while the tree is allowed to sway in the wind, thus relieving the wire of all strain.

The carbon holder, shown in Fig. 4, is claimed to be an improvement over any other in use. When the thumb screw is turned to take out the carbon, it holds the adjustable part of the holder open ready to receive the new carbon. The operation will be readily understood by reference to the illustration.

The arc lamp insulation, Fig. 5, is intended for use upon lamps that are necessarily hung so low as to admit of being accidentally touched. It is made to fit any style of lamp.

The detachable pole step for trimmers, shown in Fig. 6, does away with the necessity of the trimmer carrying a ladder, in addition to his load of carbons. A socket is fastened to each side of the pole, and the trimmer, taking two small steps, places one in each of the sockets, goes up the pole, trims the lamp, comes down, takes out his steps, replaces them in his pocket, and goes to the next lamp post, and so on, thus accomplishing a greater amount of work.

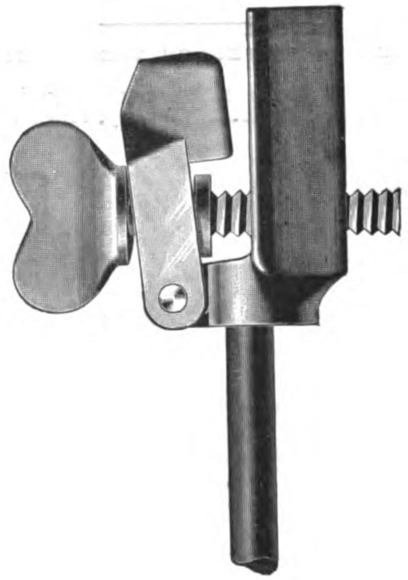


FIG. 4.—CARBON HOLDER.

The cable clip, Fig. 7, is simple in construction, easily adjusted in passing a fixture, and very durable, being made of the best galvanized iron. (For Figs. 6 and 7, see page 212.)

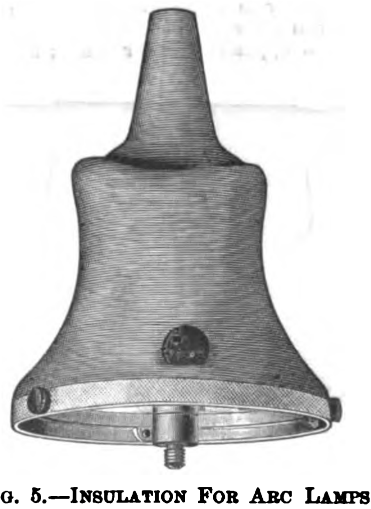


FIG. 5.—INSULATION FOR ARC LAMPS.

PAGE BELTING CO.

The above standard belting house has lately opened a fine New York store at 16 Dey street, right in the heart of the electrical district, and there is carrying a remarkably complete and well selected stock of belting, lace leather, cut lacings, etc. As is well known, the company make a specialty of belting for electrical purposes, and are celebrated for the dynamo double belts, "Eureka" dynamo belt, "Crown" extra short lap oak belt and "Acme" leather link belt. Mr. George A. Pierce is manager of the New York branch and invites electrical people to call and inspect the company's goods.

AMERICAN ELECTRICAL WORKS.

In connection with the meeting of the N. E. L. A. in Providence this week President Eugene Phillips, of the American Electrical Works, announces the intention of that concern to celebrate the opening of its new factory by an entertainment or reception there on Thursday evening, February 19. Mr. Phillips is not in the habit of inviting people freely into his factories, but on this occasion the rule will be broken and the place will be the scene of unlimited hospitality. Those who are familiar with the summer festivities of the Works are a little curious to see how a clambake, under the same auspices, will go in winter, but we know that they will be able to say of Mr. Phillips what Florizel said of Perdita: "What you do, still betters what is done."

CLEVERLY'S PERFECTION THERMOMETER.

Not satisfied with the sensation created by his blotting pads and artistic calendars, Mr. H. A. Cleverly, 1018 Chestnut street, Philadelphia, has brought out a new combined electric light molding and shingle, on which he has placed a "perfection" thermometer. In order to indicate the warmth of his feelings towards a customer in whose pocket lurks a big order, Mr. Cleverly has placed one arrow opposite "Fever heat"; and in order to illustrate his sentiments towards advertising canvassers, he has placed another arrow 30 degrees below zero. At the back of the shingle are instructions as to what should be done in case the "column of red liquid" gets broken up, the remedy being "one or two swift downward swings, stopping with a sudden jerk, almost in the same manner that you would wield an axe in chopping wood." It happens, however, that the column in the Cleverly thermometer contains a *purple* liquid, and, as everybody knows, the calisthenic exercises with a purple column are quite different. This is only another of Cleverly's deeply-planned Philadelphian jokes.

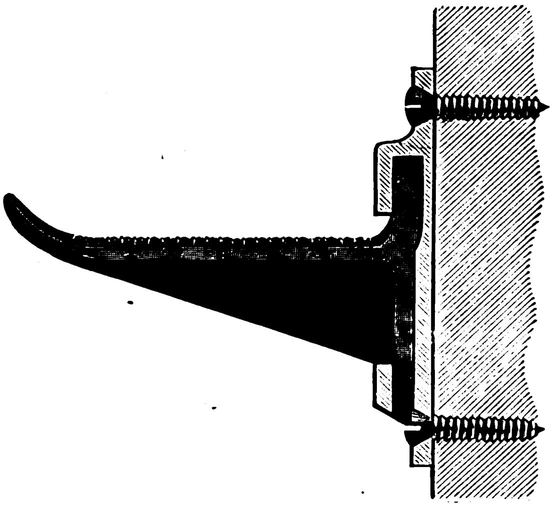


FIG. 6.—ADJUSTABLE POLE STEP. (*See page* 211.)

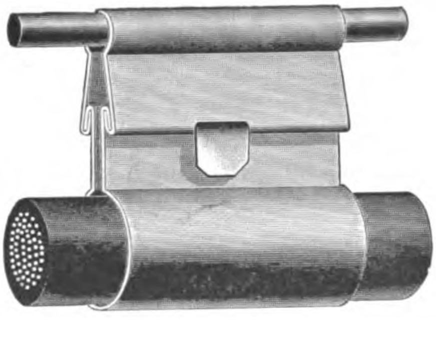


FIG. 7.—CABLE CLIP. (*See page* 211.)

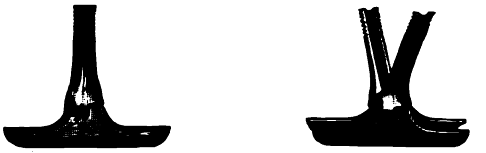
THE SOUTHERN ELECTRICAL SUPPLY CO., 823 Locust street, St. Louis, who make a specialty of Okonite wires and cables, had a most prosperous year's business. They have lately taken the agency for the Connecticut motor, and have made a number of sales.

ERNST ELECTRIC STORAGE COMPANY.

This company has been organized to manufacture the Ernst storage battery described in our issue of February 11th. The patents of Mr. V. H. Ernst cover a variety of improvements in storage batteries, and it is expected that cells will soon be ready for the market. The officers of the company are Thomas Grimwood, president; Joseph Thomson, vice-president, and Smith S. Frambes, secretary and treasurer. The offices of the company are at 115 Broadway, this city.

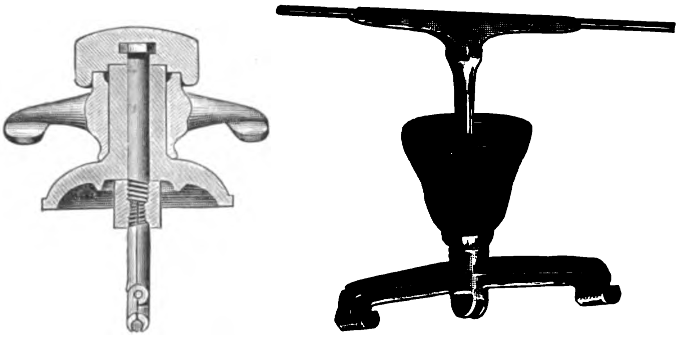
A NOVEL TROLLEY WIRE CLAMP.

ONE of the most important features in the installation of an electric road is the proper construction of the appliances for connecting the span and trolley wires. Objections have been made to the present means of holding the trolley wire, for the reason that it has been necessary in most cases either to solder the connections, which necessarily weakens the wire, or else to hammer together the sides of the clamp, which causes trouble and delay in adjusting the position of the insulator.



FIGS. 1 AND 2.—THE BREWSTER TROLLEY WIRE CLAMP.

The accompanying illustrations show the "Brewster clamp," made by the Electric Merchandise Co., of 11 Adams street, Chicago. Figs. 1 and 2 show the clamp, which is made of two sections of hard and tough brass rivetted together with a steel pin. After the clamp has been placed upon the trolley wire and closed, the insulator is screwed down upon it, firmly holding the wire without soldering or hammering, and presenting a perfectly smooth surface to the trolley. Figs. 3 and 4 show the clamp attached to the standard trolley wire insulators, but the clamp can be used on any trolley hanger, and is sold either separate or in connection with any other style of insulator.



FIGS. 3 AND 4.—THE BREWSTER TROLLEY WIRE CLAMP.

Mr. Mason, the general manager of the company, will be at the Providence convention, with this and many other specialties.

ROOT WATER TUBE BOILERS.

A large number of Root new water tube steam boilers are in use in electric light and power stations. The manufacturers, the Abendroth & Root Manufacturing Co., 28 Cliff street, New York, are very busy and find the demand for their specialty steadily growing greater and more general. They have shipped a large number of their boilers to Cuba recently.

NEW YORK BELTING & PACKING CO.

All kinds of vulcanized rubber goods of the best quality for mechanical purposes can be found at the warerooms of the New York Belting & Packing Co., 15 Park Row, New York. The goods made by this concern can be found in every civilized portion of the world, and are famous for their durability and fine workmanship.

OKONITE.

Messrs. Candee, Manson, Cheever and McCoubray will be at the convention in the interests of the International Okonite Company, Limited, New York and London. Okonite insulated wires and cables have attained an enviable degree of popularity, and keep on going higher in public favor day by day.

THE INTERNATIONAL OKONITE COMPANY, LIMITED.

In a recent issue, The Electrical Engineer had occasion to describe the offices of the International Okonite Company, at 13 Park Row, New York.

The leading lights of the New York end of this company are the gentlemen whose portraits are here given. Captain Willard L. Candee was born in the year 1851, at Yonkers, Westchester County, N. Y., whence he subsequently removed to Brooklyn, N. Y. He is well known socially in that city, where he holds the captaincy of Company B, in the crack 23rd regiment. He has been connected with the International Okonite Company since its start, and to his efforts is due largely the proud position occupied by this concern among American manufacturers to-day

Willard L. Candee.

Mr. H. Durant Cheever, who, with Mr. Candee, conducts the business management of the company in America, was born in New York city 25 years ago. Mr. Cheever is a graduate of Harvard and became associated with the company in July, 1888, directly after completing his course at College. He is a thorough business man, bright and progressive, and has no doubt a prominent business career before him.

H. Durant Cheever.

Mr. George T. Manson is probably one of the best known men in the electrical field. He is a native of Massachusetts and 40 years of age, and has been connected five years with the International Okonite Company, where he co-operates with Messrs. Candee and Cheever in the business management of the concern. Mr. Manson was previously interested for many years in the New England Telephone and Telegraph Company, of Boston, Mass. His whole-souled, genial nature has won for him a host of friends.

Mr. F. Cazenove Jones, general manager of the company's factories, at Passaic, N. J., was born in Maryland 35 years ago, and is a descendant of Captain John Paul Jones, whose bold manœuvres embarrassed English commerce so much during the Revolution. Mr. Jones has been connected with the International Okonite Company for many years, and his thorough knowledge of mechanics, and long experience with the New York Belting and Packing Company—he having for a long time had charge of the manufacturing departments of this concern at Passaic, N. J., and Newtown, Conn.—fit him specially for the important position he occupies.

George T. Manson.

F. Cazenove Jones.

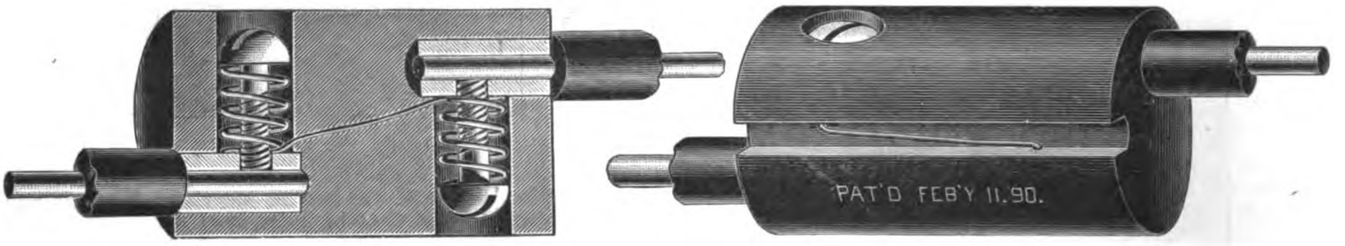
MR. BENJAMIN R. WESTERN.

Few manufacturers have the time and inclination to attend to the exacting details of profitable advertising. It is a business in itself and requires one's undivided time and attention. Those who want to be well served in this regard, should employ the services of an expert skilled in such matters. Mr. Benjamin R. Western, proprietor of the Manufacturers' Advertising Bureau and Press Agency, 111 Liberty street, New York, is amply able to fill the bill, and will be at the convention with an inexhaustible fund of shrewd and invaluable information regarding advertising. Mr. Western ought to write a book on "Successful Advertising."

A NOVEL THERMAL CUT-OUT.

THE accompanying illustrations show the novel thermal cut-out manufactured by the Electrical Specialty Company, Nos. 18 and 20 Cortlandt street, this city. The illustrations, Figs. 1 and 2, are three times the actual size of the device, one showing the cut-out in use, the other the interior arrangement of it. It will be noticed that this safety catch for electric circuits consists of a cylindrical block of hard rubber having only two binding screws for the line conductor, one at each end, and on opposite sides. The block is provided with an external groove on one side for the fuse wire leading from one binding screw to the other. A short spiral spring is inserted under the head of each screw and binds directly upon the fuse wire, thus ensuring a perfect contact, no matter how far the binding screw penetrates in the opening.

The cylindrical block in each end of the cut-out into which the conductors are inserted and through which the binding screw passes, makes a perfect contact all around the wire, instead of a contact met by the end of the binding screw and merely resting on the fuse wire. The cut-out is designed for use in almost any place where a safety catch is needed, but is of especial value where but a small space is available, such as in electroliers and brackets where it has been necessary heretofore to make large and unsightly canopies or cut-shaped shields to cover the safety catches required. No tape is required to insulate this fuse block as all metallic parts are countersunk in the hard rubber. The simplicity of construction renders it an easy matter to replace a burnt-out fuse wire without danger of burning the fingers. This cut-out will be of value in interior conduit work. The fuses can be easily renewed but the user will save time by putting on a new cut-out and renewing the fuse in the old one at his leisure. The company propose to manufacture this novelty for all sizes but at present it is made only for from one to three lights.



FIGS. 1 AND 2—A NOVEL THERMAL CUT-OUT.

SOME RECENT FORT WAYNE PLANTS.

The following business has been done by Mr. Thomas Cooper, special agent for the Fort Wayne Electric Co., and Mr. W. J. Morrison, from the Buffalo office, during the past six weeks: City of Jamestown, N. Y., 150 arc lights; Batavia, N Y., 120 arc lights; Warsaw, N. Y., 60 arc lights, 750 alternating; Niagara Falls, Ont., 60 arc lights; U. S. Elec. Light & Power Co., Buffalo, 80 arc lights. Not too "frosty" a trade for six weeks.

THE NEW PARTRICK & CARTER HEADQUARTERS.

Partrick & Carter Co., of Philadelphia, who have been established since 1867, report trade as being very good for this season, and they look forward to a busy year for those engaged in electrical pursuits.

Their new establishment at No. 125 South Second street, and No. 131 Gothic street is now in perfect running order, and they have one of the best appointed and most attractive electrical supply houses to be found anywhere. Their store and show room is 120 feet in length by 20 feet in width, and is fitted up in the most approved manner for the display and storage of their stock of which they carry a large line.

A distinguishing feature of the store is the lettering of all drawers, cupboards and bins so that he who runs (or walks) about 120 feet away may read the names of the million and two articles which go to make up the stock of a fully equipped electrical supply house.

The counting-rooms and private offices are located on the first floor of No. 125 South Second street, and the packing and shipping department is in a wing 50 feet by 20 feet running through to Gothic street. The buildings are five stories in height, and are occupied exclusively by Partrick & Carter Co., the upper floors being devoted to the factory of the firm, who own and operate the steam power and heating plant together with an electric lighting system. Their factory has always been a well equipped one, and since becoming located in their new buildings they have added largely to their facilities by additional machinery and force. They are now making up their specialties of patent needle annunciators, bells, batteries, etc., together with their regular lines in larger quantities than ever before. Their 1891 catalogue is now in the hands of the printer, and will come from the press shortly. Its issue has been delayed on account of their removal and other changes. The catalogue will be the most complete ever published by this old established firm, and a copy should be in the hands of all who buy electrical supplies.

THE "ELGIN" TELEPHONES.

The Elgin Telephone & Electrical Supply Co., of Elgin, Ill., report that their acoustic or mechanical telephones are becoming popular in foreign countries, not less than in the United States. They have lately received orders from Stockholm, Sweden; Preston, England; and Moscow, Russia, as well as other foreign places. They have lately added an attachment in the shape of a mechanical bell which they claim rings as well as an electrical vibrating bell, and which they put in when a bell call is desired.

CORNELL ELECTRICAL ENGINEERING CO.

THIS concern which has just opened an office at 45 Broadway, this city, is composed of thorough business men who have also had practical experience with the details of electric railway lighting and power work. They will do a general business as consulting and constructing engineers, but will devote themselves particularly to the equipping of electric railways.

The company depends for success on the very fact which causes uneasiness in so many quarters, viz:—that purchasers of electric plants have learned to insist upon the best possible work at moderate prices. Every detail of their work will be done under the charge of skilled men, a number of whom have been actively employed by them for the past year, and the placing of a contract in the hands of the company will insure excellent work in every particular.

The company has just finished the electrical equipment of the Hamilton & Lindenwald Electric Railway, at Hamilton, Ohio, which is of the most substantial character throughout. The station equipment is the finest.

MR. GEORGE WORTHINGTON.

It is with much regret that we record the serious indisposition of Mr. George Worthington, the popular publisher of *The Electrical Review*. He will be unable to attend the National Electrical Light Convention at Providence this week, and is now with friends in Buffalo. His illness is the more unfortunate from the fact that he had been invited to take a prominent part in the decennial exercises, in recognition of the good work done by himself and colleagues at the time of the foundation of the Association. We venture to extend our sympathies both to himself and to his editorial associate, Mr. C. W. Price, at this juncture, knowing that in so doing we but voice also the sentiments of innumerable friends.

A. & W. S. CARR CO.

A. & W. S. Carr Company, of 138-140 Centre street, New York, offer some good bargains in iron pipe, valves and gates, and will quote attractive prices on iron and brass castings. Their shops and foundry at Paterson, N. J., are doing an excellent business.

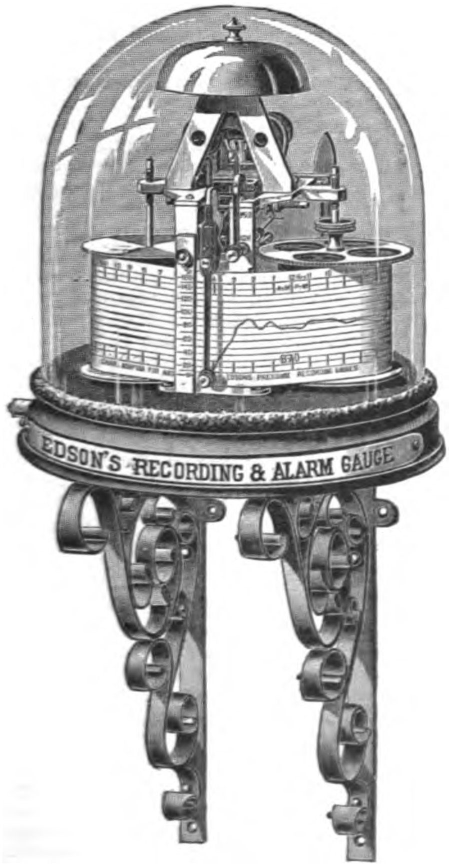
FISHKILL-CORLISS ENGINES.

The improved Fishkill-Corliss horizontal engines are especially well adapted for electric lighting plants. The best materials only are used in their construction, resulting in great durability; while the "cut-off" device used, insures what is believed to be the most economical use of fuel yet accomplished. Write the Fishkill Landing Machine Company, Fishkill-on-the-Hudson, N. Y., for a new catalogue. It is of great interest.

THE CENTRAL THOMSON-HOUSTON CO., through their agent, Mr. Alex Lewis, have just closed a contract for 6 motors with the Marion Street Railway Co., of Marion, O.

EDSON'S NEW STEAM PRESSURE-RECORDING GAUGE.

UNIFORM steam pressure is so important in operating electrical plants that some device which will enforce increased care on the part of the fireman is indispensable. Mr. Jarvis B. Edson, of 87 Liberty street, New York, who, in connection with his engineering business, has long been known for his persistency in urging the advantages of uniform steam, and the inevitable economy resulting from careful firing, has recently introduced some improvements in the construction of his well-known pressure-recorders, which we illustrate by the accompanying illustration of his style No. 1. As will be noticed, he has dispensed with the indicating hand and dial, relying upon the vertical scale solely, and in place of the hand and dial, has introduced an electric bell, current for which is conveyed through the two binding posts shown at the side of the base. This electric bell is operated by an adjustable circuit closer, shown near the vertical scale, and enables an alarm to be sounded either on the instrument, or at a distant point, when any limit of pressure at which the circuit closes has been set is reached. The modification of the arrangement provides a low circuit closer, in addition to the above, operated from the same battery, so that while the recording chart below in recording continuously the pressure carried, acts as a constant check, or reminder upon the man in the fire-room, the electric bell device undertakes to call attention to the dereliction, and enables an immediate remedy; whereas, without the alarm, the pressure might be either above or below normal for a considerable period without being noticed. The mechanical construction of this new style of instrument is a vast improvement over the older one, inasmuch as lost motion and wear is provided against, and its simplicity has admitted of a reduction in price. This style is provided with metallic paper ruled to the particular travel of the diaphragm, and spaced off in hours and half hours. The marking lead has been dispensed with and silver wire substituted, the whole being surmounted upon an ornamental black iron bracket. Any steam plant must be intelligently conducted in order to be economically maintained. The manifold duties of the superintending engineer, or manager, make it important that he should be provided with some means of knowing how the steam is carried during his absence. Neglected or overfed fires are ruinous to perfect combustion, without which fuel economy is lacking, and as absence of full information invites carelessness, encourages indifference, and, and in fact, paves the way for perpetual waste and final accident with "nobody to blame," a good pressure recording guage can not be too highly recommended.



EDSON'S NEW STEAM PRESSURE RECORDING GAUGE.

THE TAYLOR PRIMARY BATTERY.

THE demand for a powerful primary battery cell is so large that it is well worth the while of inventors to effect improvements in this class of electric generators. Among those who have attacked the problem in a successful manner is Mr. T. F. Taylor, who has invented a form of battery which embodies several new features. In this cell zinc is entirely immersed below the surface of the liquid so that there is no metal wasted as in the forms usually employed, it being suspended by a light frame which is unattacked by the liquid. The porous cups are made of special material and the contact of the multiple carbon is effected in such a manner that no corrosion takes place on the junctions. The liquid employed in the outer jar is a 6 per cent. sulphuric acid; that employed in the porous cup for depolarizing is intended to replace nitric acid with all its attendant inconveniences. The material for its composition is in the form of a powder, which can be readily shipped and solution prepared at the place where the battery is used. One remarkable feature of the cell is its very low internal resistance, which in the No. 1 cell, which measures 12x7 inches, is only .08 ohm. The electromotive force of the cell is 2 volts, so that such a cell on short circuit will give 25 amperes, which can be maintained almost indefinitely during the life of the solution. Three of these cells will keep a 3 c. p. lamp brilliantly lighted for 160 hours, and will run an eighth h. p. motor. The No. 2 cell, 8x5½ inches, will give a current of 8 amperes on short circuit, and the amateur battery, 3x8½ inches, will maintain a small Edison lamp for several hours. This cell, which has attracted considerable attention, is manufactured by Messrs. Taylor & Son, of 39 Dey street, New York.

Comparing this cell, with its very low internal resistance and high E. M. F., with the ordinary sized gravity cell, it will be evident that for local work one cell of the former replaces from 10 to 15 of the latter.

AN IMPORTANT WENSTROM ELECTRIC RAILWAY CONTRACT.

Messrs. Chadbourne, Hazelton & Co., of Philadelphia, general agents of the Wenstrom Consolidated Dynamo and Motor Co., of Baltimore, have just closed a contract with the Denver, Lakewood and Golden Railway Co., of Denver, Colorado, for an extensive electric railway. This road runs from the heart of Denver directly across the country to the city of Golden, a distance of 14 miles, passing through several smaller towns on the way. The grading on this road is completed, and the work of laying the rails is about to commence. Sixty pound T rail will be used. This road is the only direct communication between these two cities, and Mr. Starkweather, vice-president and general manager of the road, claims that the freight business alone on this line will pay a 10 per cent. dividend on the investment.

The equipment at first will consist of two 100 h. p. motor cars, designed by Mr. Leonard Atwood, the mechanical expert employed by Messrs. Chadbourne, Hazelton & Co. These motor cars will be fitted with special Wenstrom slow speed direct geared motors, designed by Mr. H. F. Parshall, on the same general lines as the regular Wenstrom-Parshall slow speed street car motor. These are guaranteed to run 25 or 30 miles an hour, and haul loaded freight cars.

For the passenger traffic, long 6-wheel cars with pivotal trucks will be used. These cars will be handsomely fitted up, and have a seating capacity for about 40 people. Two standard Wenstrom slow speed, direct geared motors, 30 h. p. each, will be put on these cars. They are calculated to run 15 or 20 miles an hour, hauling two other trail cars.

The power plant will be divided into two sections; one station being in Golden, the other near Denver. Each one will be fitted up with four 80,000 watt Wenstrom street car generators of the newest and most approved design, together with the necessary steam plant to operate them. No money will be spared to make this road complete in every detail.

Chadbourne, Hazelton & Co. have had their expert, Mr. Atwood, in Denver for some weeks going carefully over this work, and laying out necessary plans for the successful equipment of the entire line. It is intended to have the road open for traffic as near the first of May as possible. They expect to increase this equipment very materially during the summer, as the traffic over this line will undoubtedly be very great.

FRANKLIN LEONARD POPE.

Mr. Franklin Leonard Pope, who was for a time in the special service of the Westinghouse Electric and Manufacturing Co., has resumed his practice as consulting electrician, expert, and general assistant to counsel in technical and patent litigation. His offices are in the new Wilks building, 15 Wall street, New York.

WESTON ELECTRICAL INSTRUMENT CO.

Advices from the Weston Electrical Instrument Company, Newark, N. J., indicate a growing demand for the company's standard portable direct-reading voltmeters and ammeters. The company has been exceedingly busy of late, and the outlook for the ensuing year is very promising.

A NOVEL THERMAL CUT-OUT.

THE accompanying illustrations show the novel thermal cut-out manufactured by the Electrical Specialty Company, [illegible] and 20 Cortlandt street, this city. The illustrations [illegible] are three times the actual size of the device, one showing the cut-out in use, the other the interior arrangement of [illegible] noticed that this safety catch for electric circuits [illegible] of a cylindrical block of hard rubber having [illegible] screws for the line conductor, [illegible] sides. The block is provided with [illegible] for the fuse wire leading from [illegible] short spiral spring is inserted [illegible] binds directly upon the fuse [illegible] no matter how far the [illegible]

The cylindrical block [illegible] conductors are inserted [illegible] passes, makes a perfect [illegible] contact [illegible] on the fuse [illegible] place, where [illegible] supplies [illegible] of 150 [illegible] an ex- [illegible] a num- [illegible] and their [illegible] they have [illegible]

[illegible]

The Crocker-Wheeler [illegible] Company has secured as [illegible] whose long and successful [illegible] Railway and Motor Company [illegible] sufficient guarantee that the [illegible] will be found at the head of the procession.

[illegible] ELECTRIC RAILWAY SYSTEM.

The Detroit [illegible] Works are reported by Mr. C. A. [illegible] manager, to be busier than ever, filling [illegible] railway equipments. They have sold during [illegible] outfits, namely, two for the Richmond [illegible] Railway, of Richmond, Va., and two for the [illegible] Railway Co. Both these are equipped already with [illegible] make. Mr. W. A. Stadelman, the company's Philadelphia agent, secured these contracts.

NEW YORK GOSSIP.

WM. E. DAVIS, late of the engineering department of the Edison Company, is now superintendent of the Toronto Incandescent Electric Light Company and has located there permanently.

THE INDIA RUBBER & GUTTA-PERCHA INSULATING WIRE COMPANY have removed their offices to 315 Madison avenue, corner of 42d street, and are comfortably installed in their new quarters and ready to meet their old friends at the above address.

WESTERN TRADE NOTES.

MR. EDWARD R. GRIER, brother of Thos. G. Grier, engineer of the National Engineering Bureau, and well-known in electrical circles in the West, has been appointed superintendent of the Southern Electric Company, of Philadelphia, Pa. He was formerly associated with the North American Construction Co., which well-known concern was evolved from the old Marr Construction Co. Mr. E. R. Grier was one of the experts on the Hoosic Tunnel installation of the Westinghouse system, which was one of the notable plants of the country when put in, and he invented the joint used on the lead covered cables employed in carrying out that work. He was also electrical expert on the private residence plant of George Westinghouse.

MR. GEORGE CUTTER, the "Electrical Specialist" of the West, will once more handle the famous "Simplex" wires and cables. He will carry a large and extensive stock of all sizes in the Rookery, where he has secured ample space in the basement for the purpose; and all orders will receive that prompt attention and despatch for which Mr. Cutter is noted.

MR. J. S. SPRUANCE, of the Star Electrix Co., of Philadelphia, Pa., was a recent welcome visitor to Chicago. He visited on his trip Minneapolis, St. Paul, and other Western cities and found Star Electrix specialties in demand everywhere.

MR. G. A. EDWARD KOHLER, the representative of the Eddy Motor Co., of Manchester, Conn., reports the following sales of motors during the past month: Five 2 h. p.; one 3 h. p.; three 5 h. p.; one 7½ h. p., and two 10 h. p. machines, making an aggregate of 55½ h. p. This record shows how rapidly these motors, which embody such excellent mechanical, electrical and scientific principles in construction, are finding wide employment and favor in the West.

THE [illegible] ELECTRIC MATERIAL COMPANY, Rooker [illegible] have brought out a new catalogue which is actual [illegible] unique in its line. The printing in color and typo [illegible] unique, the arrangement of the many standard articl [illegible] specialties which they handle is also unique, and lastly, t [illegible] of the book which presents the two pages to the read [illegible] it being read from top to bottom, down both sheets, [illegible]. It reflects the greatest credit on Mr. Ernest Hoefer, t general manager of the company, who got it up, as being som thing of a decidedly handy size and novel form and is especial adapted to being found in the pockets of the purchasers of ele tric light power or railway supplies, from which it will also dra the weighty silver dollars in exchange for the enticing goods di played in its pages. Truly it is a pleasant thing to see a real novel catalogue.

MR. D. B. DEAN, so long and favorably known as the energet and versatile Western representative of the *Electrical Review* New York, has resigned his position with our esteemed conte porary, and has accepted a position as traveling representative the Electric Merchandise Co., of this city. His wide acquaintan and pushing qualities peculiarly fit him for his new sphere work. He will find himself in congenial companionship with M W. R. Mason, the manager of the Electric Merchandise Co., a Mr. Dean will make a highly active and efficient representative that well known concern.

MR. H. JENKINS, who until recently has been associated wi the National Engineering Bureau, has now connected hims with the Pond Engineering Co. and will shortly proceed Omaha, where he will take charge of their office. Mr. Jenkins a hard worker, full of energy, and push and will make his ma in the engineering business in Nebraska and neighboring ter tory.

THE CHICAGO RAWHIDE MANUFACTURING CO., 75 and 77 O street, Chicago, are meeting with great success with the Mal hydraulic rawhide packing, which they manufacture. This pa ing has many marked advantages particularly in wearing qu ties, and is easily compressed, being a soft packing, thereby co pensating for its slight wear. It will not cut a rod, plunger cylinder, on account of the method of curing the rawhide, wh causes it to act as a lubricant and effect a notable saving in pow It is adapted for all purposes where a cool water packing employed for freezing, hydraulic machines and the like.

MR. CROLIUS, of the Globe Light and Heat Co., Michigan str Chicago, is very busy extending the electrical specialty dep ment of the company. They will bring out a number of n designs in fixtures and so forth for electrical work, and are do a brisk and increasing business.

NEW ENGLAND TRADE NOTES.

CLAFLIN AND KIMBALL have opened an office at 116 Bedf street, Boston, and will hereafter act as general agents for Perkins Electric Lamp Company, of Manchester, Conn., and conduct the entire selling department of that company. All c respondence should be directed to them regarding sale or p chase of Perkins incandescent lamps, when it will receive same prompt attention as heretofore.

MR. W. C. FISH, who has recently returned from a th years' trip to the other side of the water, where he has been i mately connected with electrical enterprise, has recently beco associated with Mr. H. B. Cram in the management of the Be stein Electric Company, of Boston. Mr. Fish's wide experie and accurate knowledge of the wants of the electrical fratern should make him a valuable acquisition to the Bernst Company.

THE BUCKEYE ELECTRIC COMPANY, of Cleveland, O., h opened a New England office, at 85 Water street, Boston, w Mr. Louis R. Wallis as resident New England agent. Mr. Wa is well acquainted with the incandescent lamp business, hav been for several years connected with the Bernstein Electric and he already reports a large demand for the Buckeye lamp.

THE GOULD AND WATSON COMPANY, the well-known dealer mica, and manufacturers of moulded mica insulators, h opened a branch office at 170 Washington street, Chicago, un the management of Mr. R. B. Pierpont, who has been connec with them for some years in Boston. The demand for moul mica still grows, and it has now got to be regarded, from the of experience, as one of the very best insulators known.

THE SHIPMAN ENGINE COMPANY, of 200 Summer street, Bost have recently shipped one of their four horse power automatic gines to Don Carlos Pacheco, Vera Cruz, Mexico, for driving a sn electric dynamo, and a two anda four horse power engine to Ho lulu also for electrical purposes. The Shipman automatic eng uses kerosene for fuel, and is made with boiler and engine c plete. They are made in sizes of from one to eight horse power, and are simple, durable and efficient. They are admirably adapted for running small electric plants, requiring no skilled care, and making no dirt or dust.

FOR L CIRCUITS.

ssachusetts Electrical

488	490	492	494	496	498	500	568	570	572	574	576	578	580	582	584	586	588	590	592	594	596	Volts.	
.7	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	1	
1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2	
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4	3	
2.6	2.6	2.6	2.6	2.7	2.7	2.7	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	4	
3.3	3.3	3.3	3.3	3.3	3.3	3.4	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	4.0	4.0	4.0	4.0	5	
3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.8	6	
4.6	4.6	4.6	4.6	4.7	4.7	4.7	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.5	5.5	5.5	5.5	5.5	5.6	5.6	5.6	7	
5.2	5.3	5.3	5.3	5.3	5.3	5.4	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.2	6.3	6.3	6.3	6.3	6.3	6.4	6.4	8	
5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.9	6.9	6.9	6.9	6.9	7.0	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.2	7.2	9	
6.5	6.6	6.6	6.6	6.6	6.7	6.7	7.6	7.6	7.7	7.7	7.7	7.7	7.8	7.8	7.8	7.9	7.9	7.9	7.9	8.0	8.0	10	
7.8	7.9	7.9	7.9	8.0	8.0	8.0	9.1	9.2	9.2	9.2	9.3	9.3	9.3	9.4	9.4	9.4	9.5	9.5	9.5	9.6	9.6	12	
9.2	9.2	9.2	9.3	9.3	9.3	9.4	10.7	10.7	10.7	10.8	10.8	10.8	10.9	10.9	11.0	11.0	11.0	11.1	11.1	11.1	11.2	14	
10.5	10.5	10.6	10.6	10.6	10.7	10.7	12.2	12.2	12.3	12.3	12.4	12.4	12.4	12.5	12.5	12.6	12.6	12.7	12.7	12.7	12.8	16	
11.8	11.8	11.9	11.9	12.0	12.0	12.1	13.7	13.8	13.8	13.8	13.9	13.9	14.0	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4	18	
13.1	13.1	13.2	13.2	13.3	13.4	13.4	15.2	15.3	15.3	15.4	15.4	15.5	15.5	15.6	15.7	15.7	15.8	15.8	15.9	15.9	16.0	20	
14.4	14.5	14.5	14.6	14.6	14.7	14.7	16.8	16.8	16.9	16.9	17.0	17.0	17.1	17.2	17.2	17.3	17.3	17.4	17.5	17.5	17.6	22	
15.7	15.8	15.8	15.9	16.0	16.0	16.1	18.3	18.3	18.4	18.5	18.5	18.6	18.7	18.7	18.8	18.9	18.9	19.0	19.0	19.1	19.2	24	
17.0	17.1	17.1	17.2	17.3	17.4	17.4	19.8	19.9	19.9	20.0	20.1	20.1	20.2	20.3	20.4	20.4	20.5	20.6	20.6	20.7	20.8	26	
18.3	18.4	18.5	18.5	18.6	18.7	18.8	21.3	21.4	21.5	21.5	21.6	21.7	21.8	21.8	21.9	22.0	22.1	22.1	22.2	22.3	22.4	28	
19.6	19.7	19.8	19.9	19.9	20.0	20.1	22.8	22.9	23.0	23.1	23.2	23.2	23.3	23.4	23.5	23.6	23.6	23.7	23.8	23.9	24.0	30	
20.9	21.0	21.1	21.2	21.3	21.4	21.4	24.4	24.5	24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.1	25.2	25.3	25.4	25.5	25.6	32	
22.2	22.3	22.4	22.5	22.6	22.7	22.8	25.9	26.0	26.1	26.2	26.3	26.3	26.4	26.5	26 6	26.7	26.8	26.9	27.0	27.1	27.2	34	
23.5	23.6	23.7	23.8	23.9	24.0	24.1	27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	36	
24.9	25.0	25.1	25.2	25.3	25.4	25.5	28.9	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	30.0	30.1	30.2	30.3	30.4	38	
26.2	26.3	26.4	26.5	26.6	26.7	26.8	30.5	30.6	30.7	30.8	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	32.0	40	
27.5	27.6	27.7	27.8	27.9	28.0	28.2	32.0	32.1	32.2	32.3	32.4	32.5	32.7	32.8	32.9	33.0	33.1	33.2	33.3	33.4	33.6	42	Amperes.
28.8	28.9	29.0	29.1	29.3	29.4	29.5	33.5	33.6	33.7	33.9	34.0	34.1	34.2	34.3	34.4	34.6	34.7	34.8	34.9	35.0	35.2	44	
30.1	30.2	30.3	30.5	30.6	30.7	30.8	35.0	35.1	35.3	35.4	35.5	35.6	35.8	35.9	36.0	36.1	36.3	36.4	36.5	36.6	36.8	46	
31.4	31.5	31.7	31.8	31.9	32.0	32.2	36.5	36.7	36.8	36.9	37.1	37.2	37.3	37.4	37.6	37.7	37.8	38.0	38.1	38.2	38.3	48	
32.7	32.8	33.0	33.1	33.2	33.4	33.5	38.1	38.2	38.3	38.5	38.6	38.7	38.9	39.0	39.1	39.3	39.4	39.5	39.7	39.8	39.9	50	
34.0	34.2	34.3	34.4	34.6	34.7	34.9	39.6	39.7	39.9	40.0	40.2	40.3	40.4	40.6	40.7	40.8	41.0	41.1	41.3	41.4	41.5	52	
35.3	35.5	35.6	35.8	35.9	36.0	36.2	41.1	41.3	41.4	41.5	41.7	41.8	42.0	42.1	42.3	42.4	42.6	42.7	42.9	43.0	43.1	54	
36.6	36.8	36.9	37.1	37.2	37.4	37.5	42.6	42.8	42.9	43.1	43.2	43.4	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	56	
37.9	38.1	38.3	38.4	38.6	38.7	38.9	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4	45.6	45.7	45.9	46.0	46.2	46.3	58	
39.2	39.5	39.6	39.7	39.9	40.1	40.2	45.7	45.8	46.0	46.2	46.3	46.5	46.6	46.8	47.0	47.1	47.3	47.5	47.6	47.8	47.9	60	
40.6	40.7	40.9	41.1	41.2	41.4	41.6	47.2	47.4	47.5	47.7	47.9	48.0	48.2	48.4	48.5	48.7	48.9	49.0	49.2	49.4	49.5	62	
41.9	42.0	42.2	42.4	42.6	42.7	42.9	48.7	48.9	49.1	49.2	49.4	49.6	49.8	49.9	50.1	50.3	50.4	50.6	50.8	51.0	51.1	64	
43.2	43.4	43.5	43.7	43.9	44.1	44.2	50.3	50.4	50.6	50.8	51.0	51.1	51.3	51.5	51.7	51.8	52.0	52.2	52.4	52.6	52.7	66	
44.5	44.7	44.8	45.0	45.2	45.4	45.6	51.8	52.0	52.1	52.3	52.5	52.7	52.9	53.1	53.2	53.4	53.6	53.8	54.0	54.1	54.3	68	
45.8	46.0	46.2	46.4	46.5	46.7	46.9	53.3	53.5	53.7	53.9	54.0	54.2	54.4	54.6	54.8	55.0	55.2	55.4	55.5	55.7	55.9	70	
47.1	47.3	47.5	47.7	47.9	48.1	48.3	54.8	55.0	55.2	55.4	55.6	55.8	56.0	56.2	56.4	56.6	56.8	57.0	57.1	57.3	57.5	72	
48.4	48.6	48.8	49.0	49.2	49.4	49.6	56.3	56.5	56.7	56.9	57.1	57.3	57.5	57.7	57.9	58.1	58.3	58.5	58.7	58.9	59.1	74	
49.7	49.9	50.1	50.3	50.5	50.7	50.9	57.9	58.1	58.3	58.5	58.7	58.9	59.1	59.3	59.5	59.7	59.9	60.1	60.3	60.5	60.7	76	
51.0	51.2	51.4	51.7	51.9	52.1	52.3	59.4	59.6	59.8	60.0	60.2	60.4	60.6	60.9	61.1	61.3	61.5	61.7	61.9	62.1	62.3	78	
52.3	52.5	52.8	53.0	53.2	53.4	53.6	60.9	61.1	61.3	61.6	61.8	62.0	62.2	62.4	62.6	62.8	63.1	63.3	63.5	63.7	63.9	80	
53.6	53.9	54.1	54.3	54.5	54.7	55.0	62.4	62.7	62.9	63.1	63.3	63.5	63.8	64.0	64.2	64.4	64.6	64.9	65.1	65.3	65.5	82	
54.9	55.2	55.4	55.6	55.8	56.1	56.3	64.0	64.2	64.4	64.6	64.9	65.1	65.3	65.5	65.8	66.0	66.2	66.4	66.7	66.9	67.1	84	
56.3	56.5	56.7	57.0	57.2	57.4	57.6	65.5	65.7	65.9	66.2	66.4	66.6	66.9	67.1	67.3	67.6	67.8	68.0	68.2	68.5	68.7	86	
57.6	57.8	58.0	58.3	58.5	58.7	59.0	67.0	67.2	67.5	67.7	67.9	68.2	68.4	68.7	68.9	69.1	69.4	69.6	69.8	70.1	70.3	88	
58.9	59.1	59.4	59.6	59.8	60.1	60.3	68.5	68.8	69.0	69.2	69.5	69.7	70.0	70.2	70.5	70.7	70.9	71.2	71.4	71.7	71.9	90	
60.2	60.4	60.7	60.9	61.2	61.4	61.7	70.0	70.3	70.5	70.8	71.0	71.3	71.5	71.8	72.0	72.3	72.5	72.8	73.0	73.3	73.5	92	
61.5	61.7	62.0	62.3	62.5	62.8	63.0	71.6	71.8	72.1	72.3	72.6	72.8	73.1	73.3	73.6	73.8	74.1	74.4	74.6	74.8	75.1	94	
62.8	63.1	63.3	63.6	63.8	64.1	64.3	73.1	73.4	73.6	73.9	74.1	74.4	74.6	74.9	75.2	75.4	75.7	75.9	76.2	76.4	76.7	96	
64.1	64.4	64.6	64.9	65.2	65.4	65.7	74.6	74.9	75.1	75.4	75.7	75.9	76.2	76.5	76.7	77.0	77.2	77.5	77.8	78.0	78.3	98	
65.4	65.7	66.0	66.2	66.5	66.8	67.0	76.1	76.4	76.7	76.9	77.2	77.5	77.7	78.0	78.3	78.6	78.8	79.1	79.4	79.6	79.9	100	
488	490	492	494	496	498	500	568	570	572	574	576	578	580	582	584	586	588	590	592	594	596	Volts.	

$$\frac{\quad}{r+g}\int$$

Now $i = \dfrac{E}{2R+r+g}$, and therefore,

The determination can be carried out equally well with a *differential inductor* and an ordinary single coiled galva-

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1. If we take account of the mutual and self-induction in the rest of the circuit, we arrive eventually at the formula given here.

F. P. LITTLE & CO.

This concern, of 141 East Seneca street, Buffalo, are in the field as contracting and consulting electrical engineers. They handle the National Electric alternating system, the Eddy motors and the Mather plating dynamos, and they are prepared to take contracts for electric street railroads, isolated electric light plants, long-distance transmission of light and power, etc. They also keep all kinds of electrical supplies in stock, and are the Western New York agents for the Electrical Supply Co., of Ansonia, Conn. The concern is in good shape to attend promptly and efficiently to all the business coming to it, and starts under its new auspices with the good wishes of a very large circle of friends and of an equally large clientage in the various branches of the electrical industry.

EMMET BROS. & GRISWOLD.

A handsome new Spring catalogue of electric railway supplies has just been issued by this young and active concern, of 150 Broadway. It contains descriptions aud illustrations of an excellent variety of line fixtures, trolleys, etc., and includes a number of novelties, such as their double fusible safety box and their renewable wooden teeth gear, with which latter they have supplemented their metal gears of all kinds.

MR. GEORGE W. LA RUE.

The Crocker-Wheeler Electric Motor Company has secured as sales agent Mr. George W. La Rue, whose long and successful connection with the Sprague Electric Railway and Motor Company as agent in the East, is sufficient guarantee that the Crocker-Wheeler perfected motors will be found at the head of the procession.

THE RAE ELECTRIC RAILWAY SYSTEM.

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WESTERN TRADE NOTES.

Mr. Edward R. Grier, brother of Thos. G. Grier, engineer of the National Engineering Bureau, and well-known in electrical circles in the West, has been appointed superintendent of the Southern Electric Company, of Philadelphia, Pa. He was formerly associated with the North American Construction Co., which well-known concern was evolved from the old Marr Construction Co. Mr. E. R Grier was one of the experts on the Hoosic Tunnel installation of the Westinghouse system, which was one of the notable plants of the country when put in, and he invented the joint used on the lead covered cables employed in carrying out that work. He was also electrical expert on the private residence plant of George Westinghouse.

Mr. George Cutter, the "Electrical Specialist" of the West, will once more handle the famous "Simplex" wires and cables. He will carry a large and extensive stock of all sizes in the Rookery, where he has secured ample space in the basement for the purpose; and all orders will receive that prompt attention and despatch for which Mr. Cutter is noted.

Mr. J. S. Spruance, of the Star Electrix Co., of Philadelphia, Pa., was a recent welcome visitor to Chicago. He visited on his trip Minneapolis, St. Paul, and other Western cities and found Star Electrix specialties in demand everywhere.

Mr. G. A. Edward Kohler, the representative of the Eddy Motor Co., of Manchester, Conn., reports the following sales of motors during the past month: Five 2 h. p.; one 3 h. p.; three 5 h. p.; one 7½ h. p, and two 10 h. p. machines, making an aggregate of 55½ h. p. This record shows how rapidly these motors, which embody such excellent mechanical, electrical and scientific principles in construction, are finding wide employment and favor in the West.

The Illinois Electric Material Company, Roo
Chicago, have brought out a new catalogue which is ac
something unique in its line. The printing in color and t
raphy is unique, the arrangement of the many standard a
and specialties which they handle is also unique, and lastl
opening of the book which presents the two pages to the r
at once, it being read from top to bottom, down both she
unique. It reflects the greatest credit on Mr. Ernest Hoefe
general manager of the company, who got it up, as being
thing of a decidedly handy size and novel form and is espe
adapted to being found in the pockets of the purchasers of
tric light power or railway supplies, from which it will also
the weighty silver dollars in exchange for the enticing good
played in its pages. Truly it is a pleasant thing to see a
novel catalogue.

Mr. D. B. Dean, so long and favorably known as the en
and versatile Western representative of the *Electrical Rev*
New York, has resigned his position with our esteemed co
porary, and has accepted a position as traveling representa
the Electric Merchandise Co., of this city. His wide acquai
and pushing qualities peculiarly fit him for his new sph
work. He will find himself in congenial companionship wi
W. R. Mason, the manager of the Electric Merchandise Co
Mr. Dean will make a highly active and efficient representa
that well known concern.

Mr. H. Jenkins, who until recently has been associate
the National Engineering Bureau, has now connected h
with the Pond Engineering Co. and will shortly proc
Omaha, where he will take charge of their office. Mr. Jen
a hard worker, full of energy, and push and will make his
in the engineering business in Nebraska and neighboring
tory.

The Chicago Rawhide Manufacturing Co., 75 and 7
street, Chicago, are meeting with great success with the
hydraulic rawhide packing, which they manufacture. Thi
ing has many marked advantages particularly in wearing
ties, and is easily compressed, being a soft packing, thereb
pensating for its slight wear. It will not cut a rod, plun
cylinder, on account of the method of curing the rawhide,
causes it to act as a lubricant and effect a notable saving in
It is adapted for all purposes where a cool water pac
employed for freezing, hydraulic machines and the like.

Mr. Crolius, of the Globe Light and Heat Co., Michigan
Chicago, is very busy extending the electrical specialty
ment of the company. They will bring out a number
designs in fixtures and so forth for electrical work, and ar
a brisk and increasing business.

NEW ENGLAND TRADE NOTES.

Claflin and Kimball have opened an office at 116 B
street, Boston, and will hereafter act as general agents
Perkins Electric Lamp Company, of Manchester, Conn., a
conduct the entire selling department of that company.
respondence should be directed to them regarding sale
chase of Perkins incandescent lamps, when it will rece
same prompt attention as heretofore.

Mr. W. C. Fish, who has recently returned from
years' trip to the other side of the water, where he has be
mately connected with electrical enterprise, has recently
associated with Mr. H. B. Cram in the management of th
stein Electric Company, of Boston. Mr. Fish's wide exp
and accurate knowledge of the wants of the electrical fra
should make him a valuable acquisition to the B
Company.

The Buckeye Electric Company, of Cleveland, O
opened a New England office, at 85 Water street, Bosto
Mr. Louis R. Wallis as resident New England agent. Mr.
is well acquainted with the incandescent lamp business,
been for several years connected with the Bernstein Elec
and he already reports a large demand for the Buckeye la

The Gould and Watson Company, the well-known de
mica, and manufacturers of moulded mica insulator
opened a branch office at 170 Washington street, Chicago
the management of Mr. R. B. Pierpont, who has been co
with them for some years in Boston. The demand for
mica still grows, and it has now got to be regarded, from
of experience, as one of the very best insulators known.

The Shipman Engine Company, of 200 Summer street,
have recently shipped one of their four horse power autom
gines to Don Carlos Pacheco, Vera Cruz, Mexico, for driving
electric dynamo, and a two anda four horse power engine t
lulu also for electrical purposes. The Shipman automatic
uses kerosene for fuel, and is made with boiler and engin
plete. They are made in sizes of from one to eight horse
and are simple, durable and efficient. They are admirably a
for running small electric plants, requiring no skilled c
making no dirt or dust.

FOR L CIRCUITS.

ssachusetts Electrical

488	490	492	494	496	498	500	568	570	572	574	576	578	580	582	584	586	588	590	592	594	596	Volts. Amperes.
.7	.7	.7	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	1
1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4	3
2.6	2.6	2.6	2.6	2.7	2.7	2.7	3 0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	4
3.3	3.3	3.3	3.3	3.3	3.3	3.4	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	4.0	4.0	4.0	4.0	5
3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.8	6
4.6	4.6	4.6	4.6	4.7	4.7	4.7	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.5	5.5	5.5	5.5	5.5	5.6	5.6	5.6	7
5.2	5.3	5.3	5.3	5.3	5.3	5.4	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.2	6.3	6.3	6.3	6.3	6.3	6.4	6.4	8
5.9	5.9	5.9	6.0	6.0	6.0	6.0	6.9	6.9	6.9	6.9	6.9	7.0	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.2	7.2	9
6.5	6.6	6.6	6.6	6.6	6.7	6.7	7.6	7.6	7.7	7.7	7.7	7.7	7.8	7.8	7.8	7.9	7.9	7.9	7.9	8.0	8.0	10
7.8	7.9	7.9	7.9	8.0	8.0	8.0	9.1	9.2	9.2	9.2	9.3	9.3	9.3	9.4	9.4	9.4	9.5	9.5	9.5	9.6	9.6	12
9.2	9.2	9.2	9.3	9.3	9.3	9.4	10.7	10.7	10.7	10.8	10.8	10.8	10.9	10.9	11.0	11.0	11.0	11.1	11.1	11.1	11.2	14
10.5	10.5	10.6	10.6	10.6	10.7	10.7	12.2	12.2	12.3	12.3	12.4	12.4	12.4	12.5	12.5	12.6	12.6	12.7	12.7	12.7	12.8	16
11.8	11.8	11.9	11.9	12.0	12.0	12.1	13.7	13.8	13.8	13.8	13.9	13.9	14.0	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4	18
13.1	13.1	13.2	13.2	13.3	13.4	13.4	15.2	15.3	15.3	15.4	15.4	15.5	15.5	15.6	15.7	15.7	15.8	15.8	15.9	15.9	16.0	20
14.4	14.5	14.5	14.6	14.6	14.7	14.7	16.8	16.8	16.9	16.9	17.0	17.0	17.1	17.2	17.2	17.3	17.3	17.4	17.5	17.5	17.6	22
15.7	15.8	15.8	15.9	16.0	16.0	16.1	18.3	18.3	18.4	18.5	18.5	18.6	18.7	18.7	18.8	18.9	18.9	19.0	19.0	19.1	19.2	24
17.0	17.1	17.1	17.2	17.3	17.4	17.4	19.8	19.9	19.9	20.0	20.1	20.1	20.2	20.3	20.4	20.4	20.5	20.6	20.6	20.7	20.8	26
18.3	18.4	18.5	18.5	18.6	18.7	18.8	21.3	21.4	21.5	21.5	21.6	21.7	21.8	21.8	21.9	22.0	22.1	22.1	22.2	22.3	22.4	28
19.6	19.7	19.8	19.9	19.9	20.0	20.1	22.8	22.9	23.0	23.1	23.2	23.2	23.3	23.4	23.5	23.6	23.6	23.7	23.8	23.9	24.0	30
20.9	21.0	21.1	21.2	21.3	21.4	21.4	24.4	24.5	24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.1	25.2	25.3	25.4	25.5	25.6	32
22.2	22.3	22.4	22.5	22.6	22.7	22.8	25.9	26.0	26.1	26.2	26.3	26.3	26.4	26.5	26 6	26.7	26.8	26.9	27.0	27.1	27.2	34
23.5	23.6	23.7	23.8	23.9	24.0	24.1	27.4	27.5	27.6	27.7	27.8	27.9	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	36
24.9	25.0	25.1	25.2	25.3	25.4	25.5	28.9	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	30.0	30.1	30.2	30.3	30.4	38
26.2	26.3	26.4	26.5	26.6	26.7	26.8	30.5	30.6	30.7	30.8	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	32.0	40
27.5	27.6	27.7	27.8	27.9	28.0	28.2	32.0	32.1	32.2	32.3	32.4	32.5	32.7	32.8	32.9	33.0	33.1	33.2	33.3	33.4	33.6	42
28.8	28.9	29.0	29.1	29.3	29.4	29.5	33.5	33.6	33.7	33.9	34.0	34.1	34.2	34.3	34.4	34.6	34.7	34.8	34.9	35.0	35.2	44
30.1	30.2	30.3	30.5	30.6	30.7	30.8	35.0	35.1	35.3	35.4	35.5	35.6	35.8	35.9	36.0	36.1	36.3	36.4	36.5	36.6	36.8	46
31.4	31.5	31.7	31.8	31.9	32.0	32.2	36.5	36.7	36.8	36.9	37.1	37.2	37.3	37.4	37.6	37.7	37.8	38.0	38.1	38.2	38.3	48
32.7	32.8	33.0	33.1	33.2	33.4	33.5	38.1	38.2	38.3	38.5	38.6	38.7	38.9	39.0	39.1	39.3	39.4	39.5	39.7	39.8	39.9	50
34.0	34.2	34.3	34.4	34.6	34.7	34.9	39.6	39.7	39.9	40.0	40.2	40.3	40.4	40.6	40.7	40.8	41.0	41.1	41.3	41.4	41.5	52
35.3	35.5	35.6	35.8	35.9	36.0	36.2	41.1	41.3	41.4	41.5	41.7	41.8	42.0	42.1	42.3	42.4	42.6	42.7	42.9	43.0	43.1	54
36.6	36.8	36.9	37.1	37.2	37.4	37.5	42.6	42.8	42.9	43.1	43.2	43.4	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	56
37.9	38.1	38.3	38.4	38.6	38.7	38.9	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4	45.6	45.7	45.9	46.0	46.2	46.3	58
39.2	39.5	39.6	39.7	39.9	40.1	40.2	45.7	45.8	46.0	46.2	46.3	46.5	46.6	46.8	47.0	47.1	47.3	47.5	47.6	47.8	47.9	60
40.6	40.7	40.9	41.1	41.2	41.4	41.6	47.2	47.4	47.5	47.7	47.9	48.0	48.2	48.4	48.5	48.7	48.9	49.0	49.2	49.4	49.5	62
41.9	42.0	42.2	42.4	42.6	42.7	42.9	48.7	48.9	49.1	49.2	49.4	49.6	49.8	49.9	50.1	50.3	50.4	50.6	50.8	51.0	51.1	64
43.2	43.4	43.5	43.7	43.9	44.1	44.2	50.3	50.4	50.6	50.8	51.0	51.1	51.3	51.5	51.7	51.8	52.0	52.2	52.4	52.6	52.7	66
44.5	44.7	44.8	45.0	45.2	45.4	45.6	51.8	52.0	52.1	52.3	52.5	52.7	52.9	53.1	53.2	53.4	53.6	53.8	54.0	54.1	54.3	68
45.8	46.0	46.2	46.4	46.5	46.7	46.9	53.3	53.5	53.7	53.9	54.0	54.2	54.4	54.6	54.8	55.0	55.2	55.4	55.5	55.7	55.9	70
47.1	47.3	47.5	47.7	47.9	48.1	48.3	54.8	55.0	55.2	55.4	55.6	55.8	56.0	56.2	56.4	56.6	56.8	57.0	57.1	57.3	57.5	72
48.4	48.6	48.8	49.0	49.2	49.4	49.6	56.3	56.5	56.7	56.9	57.1	57.3	57.5	57.7	57.9	58.1	58.3	58.5	58.7	58.9	59.1	74
49.7	49.9	50.1	50.3	50.5	50.7	50.9	57.9	58.1	58.3	58.5	58.7	58.9	59.1	59.3	59.5	59.7	59.9	60.1	60.3	60.5	60.7	76
51.0	51.2	51.4	51.7	51.9	52.1	52.3	59.4	59.6	59.8	60.0	60.2	60.4	60.6	60.9	61.1	61.3	61.5	61.7	61.9	62.1	62.3	78
52.3	52.5	52.8	53.0	53.2	53.4	53.6	60.9	61.1	61.3	61.6	61.8	62.0	62.2	62.4	62.6	62.8	63.1	63.3	63.5	63.7	63.9	80
53.6	53.9	54.1	54.3	54.5	54.7	55.0	62.4	62.7	62.9	63.1	63.3	63.5	63.8	64.0	64.2	64.4	64.6	64.9	65.1	65.3	65.5	82
54.9	55.2	55.4	55.6	55.8	56.1	56.3	64.0	64.2	64.4	64.6	64.9	65.1	65.3	65.5	65.8	66.0	66.2	66.4	66.7	66.9	67.1	84
56.3	56.5	56.7	57.0	57.2	57.4	57.6	65.5	65.7	65.9	66.2	66.4	66.6	66.9	67.1	67.3	67.6	67.8	68.0	68.2	68.5	68.7	86
57.6	57.8	58.0	58.3	58.5	58.7	59.0	67.0	67.2	67.5	67.7	67.9	68.2	68.4	68.7	68.9	69.1	69.4	69.6	69.8	70.1	70.3	88
58.9	59.1	59.4	59.6	59.8	60.1	60.3	68.5	68.8	69.0	69.2	69.5	69.7	70.0	70.2	70.5	70.7	70.9	71.2	71.4	71.7	71.9	90
60.2	60.4	60.7	60.9	61.2	61.4	61.7	70.0	70.3	70.5	70.8	71.0	71.3	71.5	71.8	72.0	72.3	72.5	72.8	73.0	73.3	73.5	92
61.5	61.7	62.0	62.3	62.5	62.8	63.0	71.6	71.8	72.1	72.3	72.6	72.8	73.1	73.3	73.6	73.8	74.1	74.4	74.6	74.8	75.1	94
62.8	63.1	63.3	63.6	63.8	64.1	64.3	73.1	73.4	73.6	73.9	74.1	74.4	74.6	74.9	75.2	75.4	75.7	75.9	76.2	76.4	76.7	96
64.1	64.4	64.6	64.9	65.2	65.4	65.7	74.6	74.9	75.1	75.4	75.7	75.9	76.2	76.5	76.7	77.0	77.2	77.5	77.8	78.0	78.3	98
65.4	65.7	66.0	66.2	66.5	66.8	67.0	76.1	76.4	76.7	76.9	77.2	77.5	77.7	78.0	78.3	78.6	78.8	79.1	79.4	79.6	79.9	100
488	490	492	494	496	498	500	568	570	572	574	576	578	580	582	584	586	588	590	592	594	596	Volts.

Now $i = \dfrac{E}{2R + r + g}$, and therefore,

The determination can be carried out equally well with a *differential inductor* and an ordinary single coiled galva-

---

1. If we take account of the mutual and self-induction in the rest of the circuit, we arrive eventually at the formula given here.

5 h. p.; one 7½ h. p., and two 10 h. p. machines, making an aggregate of 55½ h. p. This record shows how rapidly these motors, which embody such excellent mechanical, electrical and scientific principles in construction, are finding wide employment and favor in the West.

uses kerosene for fuel, and is made with boiler and engine complete. They are made in sizes of from one to eight horse power, and are simple, durable and efficient. They are admirably a dapted for running small electric plants, requiring no skilled care, and making no dirt or dust.

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L. RMINATION OF SELF-INDUCTION COEFFI-C. T BY MEANS OF A WEBER INDUCTOR.

BY

Samuel Sheldon

I HAVE never seen in English the following simple method for determining L by means of an inductor and a differential ballistic galvanometer. It was presented in 1887 to the class in mathematical physics at the Munich Academy of Sciences by F. Kohlrausch.

For the determination, use is made of the curious fact that, when a momentary induced current is equally divided through the two coils of a differential ballistic galvanometer, and when one of the branches contains an inductive resistance, the needle of the galvanometer will give an instantaneous deflection without any velocity at its close. This deflection is started by the inverse extra current in the one coil of the galvanometer, and is stopped by the opposite direct extra current. The magnitude of this deflection can be easily measured by means of a telescope and scale.

The arrangement of apparatus is shown in the diagram. E R is a Weber inductor, consisting of a hollow coil and two magnets with like poles opposed to each other. The magnets are fastened together "end on," and upon pushing them into the coil, a certain E. M. F. is produced. From one terminal of the coil the induced current divides through two paths, passing around the two galvanometer coils in opposite directions. One path contains the resistance r, whose self-inductive coefficient is to be determined, and the other contains an equal non-inductive resistance r'. The equality is obtained by previously employing a battery of constant voltage. At any instant of time t, let E and R equal the E. M. F. and resistance, respectively, of the inductor; $g =$ the resistance of each galvanometer coil; $i =$ the current in the resistance with self-induction and i' the current in the non-inductive branch. A little consideration will show that the E. M. F. of self-induction is

$$L\frac{di}{dt} = (i' - i)\,(r + g) \text{ or}$$

$$i' - i = \frac{L}{r+g}\,\frac{di}{dt}. \qquad (1)$$

This current excess, in the one coil of the galvanometer, gives the needle an acceleration

$$\frac{d^2 x}{dt^2} = C(i' - i) = \frac{L}{r+g}\,C\,\frac{di}{dt},$$

where C is a galvanometer constant. If the needle was at rest at the beginning of the impulse, then we have further,

$$\frac{dx}{dt} = \frac{L}{r+g}\,C\,i.$$

Now, since at the close of the impulse $i = 0$, the velocity of the needle is also 0; during the whole impulse, however, the needle has made a deflection,

$$x' = \frac{L}{r+g}\,C\int i\,dt. \qquad (2)$$

Now $i = \dfrac{E}{2R + r + g}$, and therefore,

$$\int i\,dt = \frac{1}{2R + r + g}\int E\,dt.$$

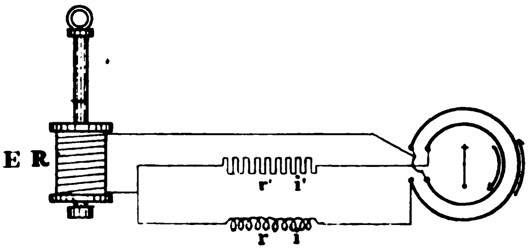
Substituting this value in (2) we obtain[1]

$$x' = \frac{L}{r+g}\,\frac{1}{2R + r + g}\,C\int E\,dt. \qquad (3)$$

In order to determine the value of $C\int E\,dt$, send a full impulse from the inductor through one of the galvanometer coils, having previously inserted a sufficiently large resistance R' in the circuit. The current then at any time t, is $I = \dfrac{E}{R + R' + g}$, which gives to the needle an acceleration $\dfrac{d^2 x}{dt^2} = C\,I = \dfrac{C\,E}{R + R' + g}$ and, at the close of the impulse, the velocity of the needle is

$$v = \frac{C}{R + R' + g}\int E\,dt, \qquad (4)$$

which causes a deflection x of the needle. Let $k =$ the damping constant of the needle; l (= nat. log. k) = natural logarithmic decrement in the experiment; and $T =$ time of oscillation of the undamped needle. Then set



$$k^{\frac{1}{\pi}\arctan\frac{\pi}{l}} = S. \qquad (5)$$

and the ordinary formula for ballistic galvanometer work gives us

$$v = x\,\frac{\pi}{T}\,S = \frac{C}{R + R' + g}\int E\,dt,$$

$$\text{and} \quad C\int E\,dt = x\,\frac{\pi}{T}\,(R + R' + g)\,S. \qquad (6)$$

Placing this in (3) and transforming, we have,

$$L = \frac{x'}{x}\,\frac{T}{\pi}\,(r + g)\,\frac{2R + r + g}{R + R' + g}\,\frac{1}{S}. \qquad (7)$$

In order to determine L we have then, besides observing the deflections x and x' to measure the resistance, and the time of oscillation and the decrement of the needle. These last can be determined sufficiently from a few swings of the needle.

An error from a slight lack of symmetry in the galvanometer coils can be eliminated by making two determinations with exchanged connections and then averaging them.

The determination can be carried out equally well with a *differential inductor* and an ordinary single coiled galvanometer, the derivation of the formulæ being very similar to that given.

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[1] If we take account of the mutual and self-induction in the rest of the circuit, we arrive eventually at the formula given here.

If the resistances be expressed in ohms, the coefficient will be in secohms; if in centimetre-seconds, it will be in henry's.

ELECTRIC POWER TABLE AND CURVES.

The accompanying curves and tables, prepared by the Massachusetts Electrical Engineering Co., of Boston, will be found of very great value to all electrical engineers, station men, and electricians generally. The tables are designed especially for 500 volt power circuits, and give the horse-power when the pressure and current are known. For less accurate work, the curves given in Fig. 1 may be used. On these, the abscissæ represent amperes, and the ordinates, volts. The nearest curve to a point obtained with any given pressure and current, is the nearest horse-power. By interpolation, a result sufficiently close for general use may be obtained. Thus, taking a circuit carrying 60 amperes at 500 volts, the lines intersect on the curve marked 40 h. p.

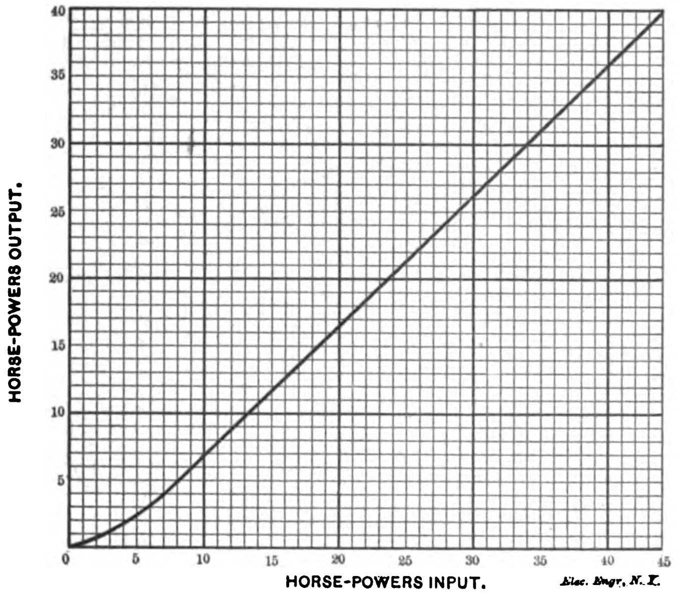


Fig. 2.—Curve for Determining Input and Output of Motors.

It is needless to add that the curves and tables may be used below and above the range given. By mentally displacing the decimal point in either direction, the values may be increased or decreased ten or one hundred fold, etc., thus greatly extending the range.

It is also evident that the volts and amperes are interchangeable, and can be taken from either the vertical or horizontal columns, respectively.

To illustrate how simple and convenient the use of electric power may be made to those comparatively ignorant of its principles, we show such a curve, Fig. 2, as is furnished by the Massachusetts Electrical Engineering Co. for power plants, to be used in connection with the horse-power tables and curves.

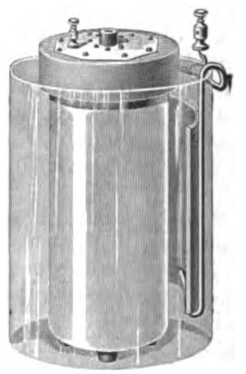
Near each motor is placed a table or curves of horse-powers similar to those here given. The attendant at any time, reading the pressure and current, determines the horse-power delivered to the motor by reference to the tables or curves. Finding this point on the "input" side of the curve, Fig. 2, he determines the "output," or power required by the machinery driven, by following the line to the vertical column on the left. Thus, 20 h. p. input intersects the curve at a point, which, if followed to the left, will give 16.5 h. p. output.

This curve is based on the efficiency of the motor at various loads and is determined by careful tests. The curve shown is that for a forty horse-power motor. A similar curve drawn for a generator would show the power delivered by the engine at any time.

THE TAYLOR PRIMARY BATTERY.

While the gravity battery leaves little to be desired so far as constancy of action is concerned, it is evident that for local work, such as the driving of small motors, the running of incandescent lamps, etc., the use of that type of cell is out of the question on account of its high resistance and its comparatively low E. M. F. With the object of producing a cell which should be constant in its action for a continuous period of time and at the same time be of low resistance and high E. M. F., Mr. T. F. Taylor has recently designed a cell which is illustrated in the accompanying engraving.

One of the distinguishing features of the Taylor battery is that the zinc is entirely immersed below the surface of the exciting liquid, being held in position by a light frame, which remains unattacked. Instead of a single carbon, as heretofore generally employed, Mr. Taylor uses a series of carbons which are connected together and to the external circuit by a joint which is not attacked by the solution employed.



The Taylor Primary Battery.

The depolarizing liquid is contained in a porous cup made of a special material, and while entirely replacing nitric acid has none of the qualities which attend the use of the latter. This depolarizing solution is made up by the addition to water of a powder and which can thus be readily shipped, and the solution prepared at the place where the battery is used.

The cell has a very low internal resistance, the No. 1 cell, measuring 12x7 inches, having only .08 ohm. The E. M. F. of the cell is 2 volts, so that on short circuit it gives a current of 25 amperes, which can be maintained throughout the life of the solution. Three of these cells are sufficient to maintain a 3 c. p. lamp brilliantly lighted for 160 hours, and are sufficient to run an 8 h. p. motor. The No. 2 cell, 8x5½ inches, gives a current of 8 amperes; and the "Amateur" battery, 3x3½ inches, is sufficient to light a small Edison lamp for several hours. These cells, which are manufactured by Messrs. Taylor & Son, of this city, have already attracted considerable attention and seem well adapted to the work for which they are intended.

F. H. Thompson, late with the Marr Construction Company, is now superintendent of the Spanish-American Light and Power Company, Consolidated, at Havana, Cuba, and a letter lately received from him says that they have a station now of 7 150 h. p. boilers and an engine capacity of 1,000 h. p., and that the station is now complete and working in the most satisfactory manner.

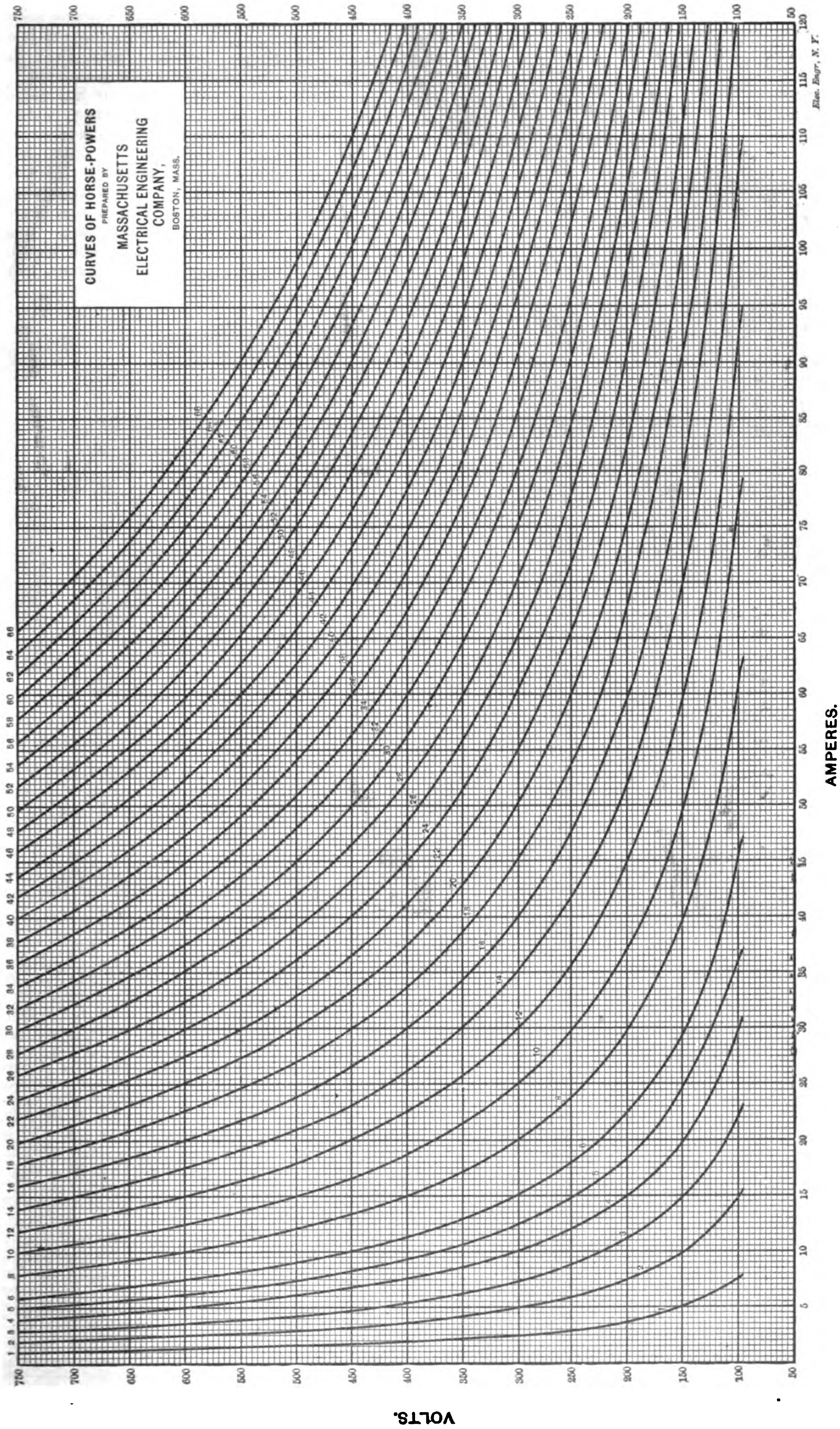


Fig. 1.—Curves for Determining Horse Powers at Various Currents and Potentials.

THE NEW CARD ARC MOTOR.

As OUR readers are aware, the Card Electric Motor and Dynamo Company, of Cincinnati, Ohio, have for some time devoted considerable attention to the construction of motors designed to be operated on arc circuits. Such machines, as a rule, are governed on a principle somewhat different from that employed in constant potential motors. The accompanying illustration, Fig. 1, shows the new arc motor just designed by the Card Company. The field, it will be seen, is of the consequent pole type, the field magnets consisting of two cylindrical coils which are wound on bobbins and slipped on the cores.

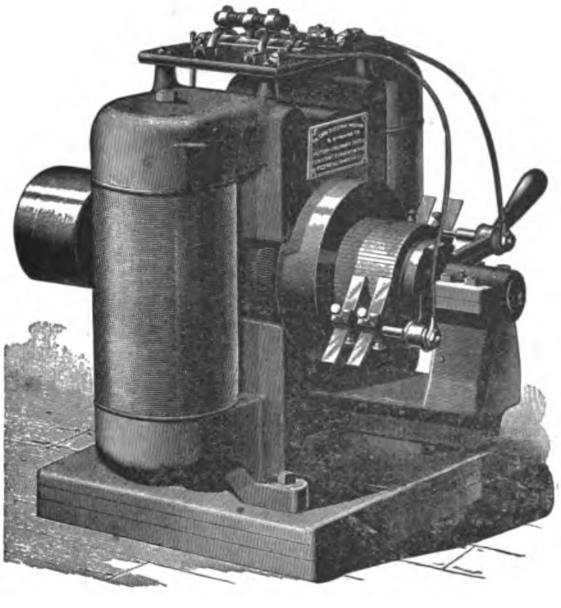


FIG. 1.—THE CARD ARC MOTOR.

The governor of the machine, which is placed at the top, is shown in detail in Fig. 2. It consists of a centrifugal governor, which is attached to the armature, and is actuated by any variation in its speed, an increase causing the field magnetizing coils to be opened and the circuit completed through the armature. The governor is so sensitive that in actual service there is no perceptible change of speed. It will readily be seen that with this governor the motor consumes current only in proportion to the load. A further advantage claimed is, that by simply turning a hard rubber button, the speed of the arc motor can be adjusted to 500 revolutions per minute slower or faster than the regular speed.

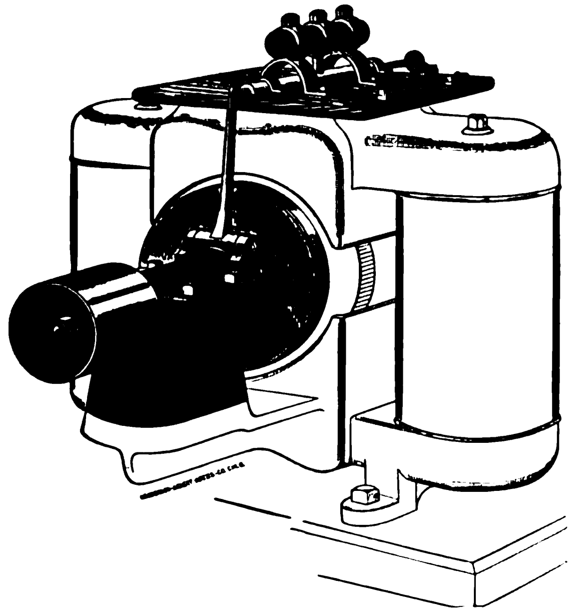


FIG. 2.—AUTOMATIC GOVERNOR OF CARD ARC MOTOR.

The mechanical design of the motor has also been very carefully worked out and a special feature is the self-oiling bearing employed. This is shown in detail in Fig. 3. As will be seen, the shaft is enclosed in a sleeve having a slit at the bottom, which permits a wheel to roll in contact with it. The lower half of this wheel dips in an oil reservoir, which forms the lower portion of the bearing and as a result of the revolution of the shaft a continual stream of oil is taken up by the small wheel and supplied to the shaft. After doing its work the oil passes to the end of the sleeve and returns to the reservoir below by the ducts at either end. These machines are built in various sizes and for the various currents employed on arc circuits.

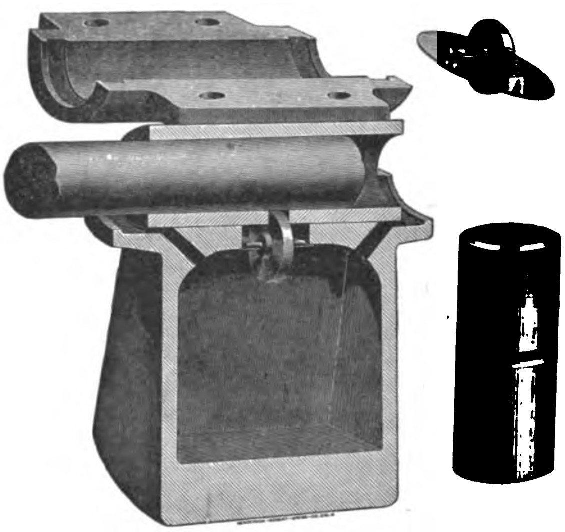


FIG. 3.—SELF-OILING BEARING OF CARD MACHINE.

Reports of Companies.

FEDERAL TELEPHONE COMPANY.—At the annual meeting of the Federal Telephone Company, held at Montreal, P. Q., on the 11th, the old Board of Directors was re-elected, with W. Cassills as president; J. Forget, vice-president, and J. Wright, manager.

WISCONSIN TELEPHONE COMPANY.—The following officers were elected by the Wisconsin Telephone Company at its annual meeting on the 9th inst.: President, H. C. Payne; vice-president, C. H. Haskins; secretary, J. D. McLeod; treasurer, F. G. Bigelow. Directors, F. G. Bigelow, G. Albree, of Chicago, B. K. Miller, H. C. Payne, C. H. Haskins, C. Ray and D. M. Benjamin, the two last being an addition to the number of those elected last year.

VERMONT INTERNATIONAL TELEGRAPH COMPANY.—At the annual meeting of the Vermont International Telegraph Company, held at St. Johnsbury, Vt., the following officers were re-elected: F. Fairbank, president; G. W. Hendee, secretary; E. A. Silsby, superintendent.

COMMERCIAL UNION TELEGRAPH COMPANY.—At the annual meeting of of the Commercial Union Telegraph Company of Maine, held at Portland on the 11th, the following directors were elected: H. S. Osgood, F. A. Dow, A. Little, S. R. Small, of Portland, H. Russell, E. J. Slattery, C. E. Arnold, of Albany, J. W. Wakefield, of Bath, G. C. Wing, of Auburn, and W. D. Pennell, of Lewiston.

ADIRONDACK TELEGRAPH AND TELEPHONE COMPANY.—At a meeting of the stockholders of the Adirondack Telegraph and Telephone Company, the following officers were elected for the ensuing year: J. W. Burdick, C. H. Erwin, W. C. Humstone, W. F. Weston, and H. L. Waterbury.

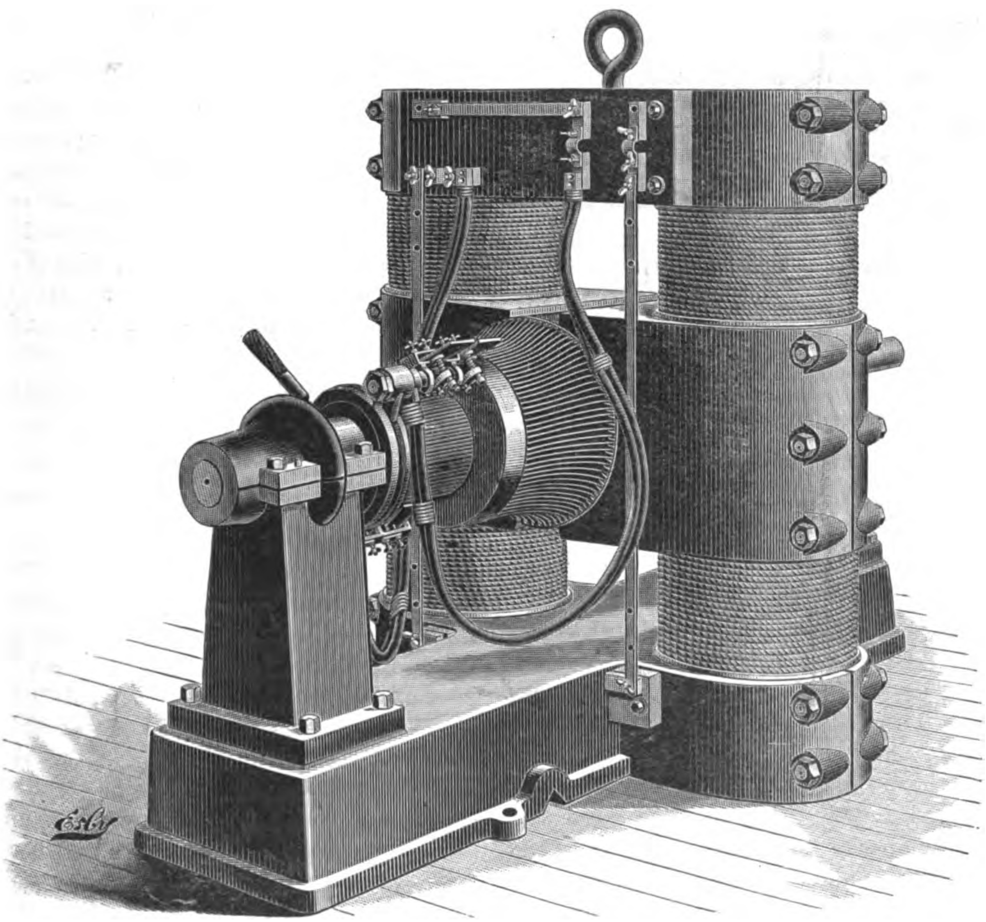
BAIN'S NEW RAILWAY AND POWER GENERATOR.

The long lines employed in electric railways and in electric power for stationary motors, have in the past frequently led to a considerable drop in potential when the demand for current was heavy, and as such a drop, means a slowing down of speed and power of the motors, just when the most power is required, some means of keeping the potential constant, and, indeed, raising it with increased loads, was desirable.

To effect this object, Mr. Foree Bain, of Chicago, has designed the machine illustrated in the accompany engraving. The generator which is specially designed for railway and stationary power circuit work is of 160,000 watts capacity at 500 volts, and weights ten tons.

The machine is compounded for a rise in potential of ten per cent. on full load. There is only 720 feet of wire on the armature, the internal resistance of which is .0184 ohm; the shunt field resistance is 365 ohms, thus giving about 1$\frac{1}{5}$ per cent. loss due to the internal resistance of the armature at full load, and less than one-half of one per cent. loss in the shunt field, and about an equal loss in the series field, thus demonstrating its excellent design and high economy.

One of the special features of all the large types of dynamos of Mr. Bain's design is that each coil on the armature is precisely of equal length, and has an insulated and positive driver firmly attached to the core, and on the large machines there is in addition an air space entirely around each wire on the armature. The dynamo is substantially built with heavy wrought iron cores, and the field coils are wound on spools and slipped over the core. The commutator is ample in size and made of pure copper, and the machine has self-oiling bearings. We may add that the Bain Electric Manufacturing Co. are prepared to build dynamos up to 400,000 watts, or 500 h. p. capacity.



BAIN'S 160,000 WATT RAILWAY AND POWER GENERATOR.

ON PHOTO-ELECTRICITY.[1]

At a recent meeting of the Physical Society, Prof. G. M. Minchin, M. A., read a paper on "Photo-Electricity," giving the result of his experiments since 1877, which, while they have not hitherto attained the object sought, have led to the discovery of many interesting phenomena.

He showed that when two silver plates coated with collodion, silver salts, or aniline dyes, are immersed in a suitable liquid, and one plate illuminated while the other is screened, electric currents are produced, having a photographic effect upon the plates.

With some cells, curious reversals take place, the exposed plate being first positive and then negative, while an increase of current, which afterward gradually disappears, results from shutting off the light. The E. M. F. of these cells rarely exceeds $\frac{1}{10}$ of a volt.

Pieces of tin foil having one side dull and the other bright, pasted on opposite sides of a piece of glass in such a manner that dissimilar sides are exposed, and immersed in alcohol, give an E. M. F. of $\frac{1}{18}$ volt, when the dull side is exposed to the light. Uncleaned tin foil plates in common tap water, also give a current, which is destroyed on cleaning the plates. Usually the exposed plate is first positive and then becomes negative, and by exposing various portions of a plate, the direction of the current may be varied. These phenomena may explain the known divergence of tin from Volta's law. A process of making very sensitive plates was described, which apparently results in the formation of a white oxide of tin on the surface of the foil. It is found that the square of the E. M. F. is proportional to the intensity of the light.

Sometimes a good cell will exhibit no E. M. F. after having been kept for a few days. When this is the case, a slight tap will restore its sensitiveness, while another tap will again destroy it, and so on. These are called impulsion cells. The sensitized plate of one of these cells had different properties at its two ends, for impulses had no effect on the nature of the lower end, but changed the upper end from positive to negative and *vice versa*. Electromagnetic impulses, such as produced by sparks, are capable of altering cells from the unsensitive to the sensitive state, but fail to produce the reverse effect; a Hertz oscillator restored the sensitive state in a cell placed at a distance of 81 feet away. The "impulsion effects" can be got rid of by renewing the alcohol on several successive days.

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[1] *Trans. Phys. Soc.*

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XI. NEW YORK, FEBRUARY 25, 1891. No. 147.

"Let it be our ambition, then, as it is our duty, to supply every demand for every kind of light and power service within reach of our stations.—Prest. Marsden J. Perry.

PEACE AND PROGRESS IN THE N. E. L. A.

THE Convention just held by the National Electric Light Association, at Providence, was beyond question the most successful in the history of that body. The registry kept by THE ELECTRICAL ENGINEER showed an attendance of 450, while there were about 50 ladies, making 500 persons present actively interested in the Association's work and future. The meetings were also attended by a large number of curious citizens, while the exhibition was crowded to suffocation at all hours. The papers were numerous and good, and the Decennial exercises were a novel and attractive feature not without merit of a kind.

So well pleased are we with the work of the Convention that we have little but praise to bestow; still it does seem that a word or two of suggestion may not be amiss. The tendency of the proceedings of a body with so many allurements into new territory is a centrifugal one, perhaps for the main reason also that a varied programme is the more likely to attract a large audience. Now, on the contrary, it should not be forgotten, and should ever be borne in mind, that the Association is intended to voice and enforce the views of local electric lighting and power companies, of which there are now at least 1,500 in this country. The operation of even the largest isolated plant entitles only to associate membership. Yet the list of subjects treated last week does not suggest any such idea. The programme traversed all creation and would not leave the impression that they who had come together had as their object the promotion and protection of central station interests.

The results of this diffuseness and indefiniteness of plan are readily to be detected. While everyone of the papers and addresses was full of meat, those which actually touched questions vital to the central station owner and superintendent got but scant time and attention. Mr. T. C. Smith's paper deserved a thorough discussion, and a whole day would not have been too much. Unfortunately it came late, and thus a golden opportunity was lost. Then Dr. Bell's report on the rating of incandescent lamps ought to have brought up a number of valuable points and hints; but it went by, at the fag end of a long day, without a whisper of comment. The report on legislation was extremely interesting, but that, too, was cut short by nightfall.

All of us want to see the Central Station men enrolling themselves, but they will not do it unless the subjects are such as come right home to their pockets and will add to their fund of experience and information. It is not a hard thing to name a dozen topics that are of first importance to central station men, and which could be discussed, in either open or executive session, with the utmost benefit.

Aside from this criticism, the results of the meeting are subject only to congratulation. The utmost harmony and kindly feeling prevailed, a good man of the best stamp was selected for president, and no one could ask for a more acceptable place of summer meeting than Montreal.

CENTRAL STATION BYE PRODUCTS.

The unreasonable clamor for reduction in rates of electric lighting, especially by many city authorities, has made it necessary for not a few companies to practice the strictest economy, and to this may, indeed, be traced some of the unfortunate affairs which have prejudiced electric lighting in the minds of the public. Aside from this, however, it seems eminently proper to consider whether the income of an electric light station cannot be increased legitimately by the utilization of what in many instances may be considered as power wasted in the exhaust steam.

Few stations are so favorably situated that condensing engines can be profitably employed, and hence the majority are in a position to entertain the subject of exhaust steam distribution. Mr. Prentiss has set forth very ably in the paper read at Providence, the conditions to be fulfilled in carrying out a scheme of this kind, but, as he remarks, each case requires special consideration to determine whether the commercial utilization of the exhaust steam can be successfully carried out. While, therefore, presenting an excellent opportunity for increasing the revenue of a station, where it can be applied, we believe that a move in this direction should only be made after the most careful study of the existing conditions. It is evident that a false step may not only reduce the profits of a paying station, but involve the sinking of capital which might, with good advantage, have been expended on improvements and extensions of the electric light plant itself. If such new work be undertaken, however, competent engineers, ought to be employed and consciencious work must be insisted upon in every detail.

THE HOSPITALITIES AT PROVIDENCE.

It would not be right to pass away from the Convention proceedings at Providence last week without acknowledgment of the endless courtesies and hospitalities of the occasion. President Perry and the proprietors of the American Electrical Works did all in their power to promote the general comfort, and their special efforts in the two receptions, on Wednesday and Thursday evenings, were simply perfect. Another pleasant feature of the meeting was the opportunity afforded of visiting some of the most celebrated factories in the country, where engines, silverware, machinery, and fine tools are made not only for home consumption but for a large and growing foreign demand. At each of these vast establishments the same cordial welcome was extended, and the principals themselves gave up their valuable time to escort their guests.

THE ELECTRIC ARC.

It is a curious fact, but none the less true, that the literature relating to the one of the oldest and most applied electrical phenomena has practically remained without notable addition since its first recorded publication. We refer here to the electric arc as such, and the phenomena observed in its operation in electric lighting as dependent upon the nature of the mechanism employed, including both dynamo and lamp. Probably no one is better able to bring out the various points of interest and importance than Prof. Elihu Thomson, whose first successes were attained in the field of arc lighting, and who has now found an opportunity of laying what must evidently be only a small part of his observations, before the National Electric Light Association. Regarding the explanation of the light-giving qualities of the arc, Prof. Thomson lays stress upon the fact that writers, even of quite recent date, have entirely forgotten, or have not known, that the principal source of illumination is the carbon vapor generated by the intense heat of the arc. The reasons which led Prof. Thomson to the utilization of the long arc in preference to the short, aside from the saving in line conductors effected by its use, are those which have probably been noted by the majority of experimenters in this direction, and are presented by him in a very concise manner. The insertion of resistances in the circuit of arc lamps operated on constant potential circuits, first practiced in connection with naval search lights, as a mere reducer of potential, was soon found to be a necessity to obtain smooth working, and the reasons for this, as stated by Prof. Thomson, go to vindicate his belief in the uselessness of attempting to operate such lamps successfully without this adjunct, made necessary by the inherent nature of the arc itself. For those who contemplate the designing of arc machines, the part of Prof. Thomson's paper relating to the arc dynamo will prove of great value, as showing the conditions which must be met in order to avoid "surging" of the lights, and which require qualities in the dynamos almost diametrically opposite to those exacted from constant potential machines. As Prof. Thomson expresses his belief in the equal fitness of closed and open circuit armatures for the purposes of arc lighting, it is fair to assume that the reasons which determined the retention for so long a time of his original three-coil armature and three-part commutator, together with its peculiar style of field, were based on good reasons, among which simplicity of construction and ease of maintenance were justly, we think, given a prominent place. The more general knowledge of electrical machinery, and the larger number of competent men available to take charge of electrical plants, has no doubt determined the departure which, we understand, has been recently effected in the Thomson-Houston apparatus in the substitution of the Gramme ring armature for the three-coil open type, so successful in the past.

Prof. Thomson's multiple carbon arc experiments will also prove of interest, and we hope that the hints thrown out by the brilliant author of many such facts and experiments still to be published, will soon be followed up by a further communication on this subject.

A Discussion on Rapid Transit.

The Electric Club of this city, with a keen appreciation of one of its many functions, has wisely decided to devote the discussion after its monthly dinner on Thursday, Feb. 26, to the very important topic of Rapid Transit. A number of leading citizens are expected, while all the various methods of carrying passengers in cities will be represented, and street railway interests will also be heard from. That the electrical side of the question will also be taken care of in the symposium is evident from the fact that it will be put forward by such men as Mr. Frank J. Sprague, Capt. Eugene Griffin, and Mr. Edward Weston. The occasion is one that all members of the Club should participate in, and we are glad to know that a very large attendance is expected. The dinner is at 6:30 at the Club House.

Testing for Faults in Underground Cables.

Probably no work in connection with the operation of central electric light stations requires more care and constant supervision than an underground system of conductors, and there is none which involves more trouble in repair when a fault develops at a point midway between terminals or junction boxes. The low resistance of the conductors employed makes the exact location of a fault exceedingly difficult, and any method by which this can be accomplished in any easy manner will, we are certain, be welcomed by many. The test described by Mr. B. T. Burt in our issue last week, which he has used with so much success in Bilbao, Spain, seems readily applicable to many cases of this nature and is sufficiently simple to be undertaken by those who have but slight acquaintance with the manipulation of electrical testing instruments.

100 Pages and Supplement Again.

Last week The Electrical Engineer consisted of 100 pages and a supplement. This week it is exactly the same size, making a total of 200 pages and 2 supplements printed and distributed in ten days. Having had some spare copies of the Cleat and Horse Power Supplements printed, we shall be glad to send an extra copy of each to any of our readers, free of charge, upon application, until the supply is exhausted.

THE B. & S. CEILING ROSETTE CUT-OUT.

The want felt by both contractor and consumer for a rosette which is easy to install, convenient to use, and handsome in appearance, has led the B. & S. Electric Equipment Co. to design the ceiling cut-out shown in the accompanying illustrations. In these Fig. 1 shows the construction of the device. As will be seen, the circuits are connected to strips having curved tongues. The flexible cord is attached to binding screws in the cap, which, in their turn, are connected by means of fusible wires to two projecting clips at the sides. A half turn of the cap causes these clips to engage with the curved tongues in the base, making a perfect rubbing contact, and holding the cap firmly in position, as shown in Fig. 2. The rosette is made of a fire and waterproof material exactly resembling hard rubber, and while having the good qualities of porcelain, is free from its brittleness and lack of finish.

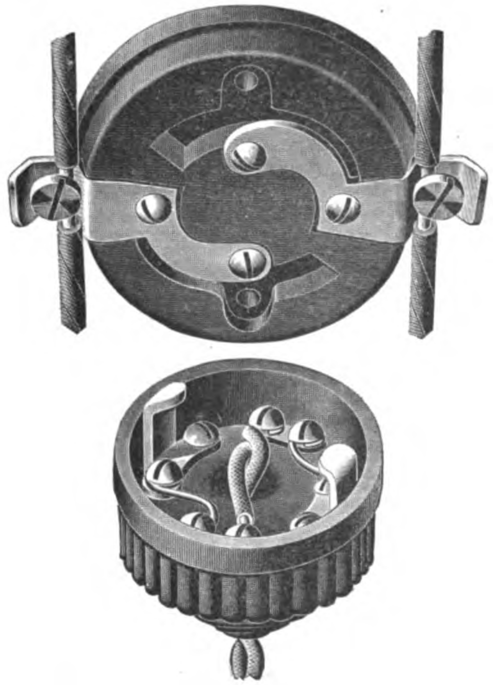


Fig. 1.—The B. & S. Rosette Cut-Out.

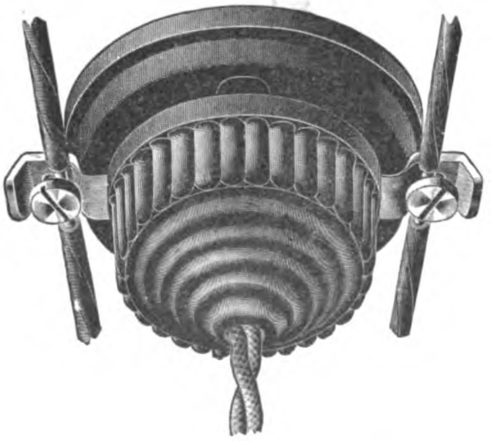
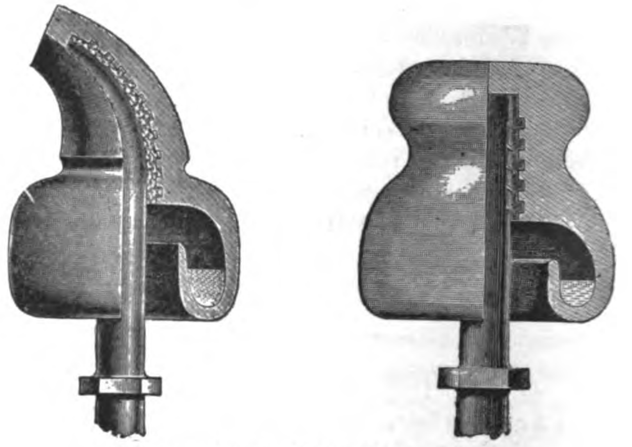


Fig. 2.—The B. & S. Rosette Cut-Out.

Boynton' Bicycle Railway Company.—At the annual meeting held on February 11th, it was decided to organize an electric sub-company, with a capital of $500,000, similar to the Bicycle R. R. Co., and to act in harmony with it. A 100 per cent. stock dividend was declared payable May 1. The following officers were elected for the ensuing year: President, E. M. Boynton; vice-president, Dr. J. B. Bell; secretary, W. H. Boynton; assistant secretary, A. B. Boynton.

FLUID INSULATORS.

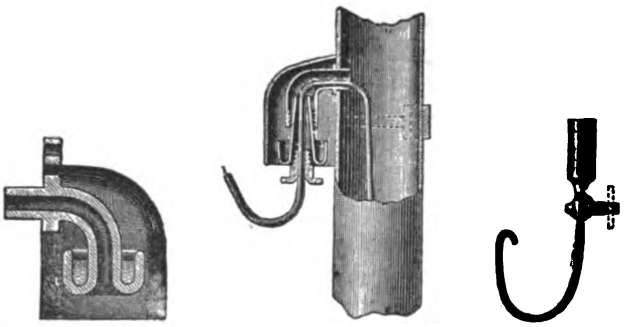
The accompanying cuts, Figs. 1 to 5, illustrate a type of insulator comparatively unknown in the United States, though used in other countries. They are manufactured by Johnson & Phillips, of London. These devices were designed for the purpose of obtaining the highest insulation by preventing surface leakage. An insulating fluid which, it is stated, will not support a film of dust or moisture, fills a recess, well protected from the weather, in the porcelain body of the insulator. In this way a clean and highly-insulating fluid surface is interposed between the line and earth. The insulators are found to be especially efficient in rainy weather.



Figs. 1 and 2.—Fluid Insulators.

These insulators, which are made in numerous patterns of either porcelain or brownware, may be employed to advantage on coast lines, where the glass or porcelain quickly becomes coated with a conducting film of salt.

The insulation fluid is manufactured by Johnson & Phillips, London, under a secret process. The fluid, it is claimed, does not freeze; it does not evaporate; and allows dust to sink to the bottom: it does not creep like paraffin or other mineral oils and lasts three or four years, even in the East Indian climate. One gallon of the insulation fluid suffices for about 20 of the smaller and 15 of the larger insulators. These insulators are handled by the Electrical Supply Company, of Chicago.



Figs. 3. 4 and 5.—Fluid Insulators and Filling Tube.

HIGHLAND PARK ELECTRIC R'Y., DETROIT, MICH.

The Highland Park R'y. was equipped by the Detroit Electrical Works with the Rae system in July, 1890. The following report of the operation of the cars is made by Superintendent Lewis, Dec. 31, 1890:

Car "Ampere":—Placed in service, July 13, 1890; No. days, 150; average miles per day, 122 4-15; total miles 18,340. Repairs, 2 brass sleeves placed in armature bearings in December.

Car "Volta":—Placed in service, July 13, 1890; No. days, 143; average miles per day, 109; total miles, 15,000. Repairs, 1 brass sleeve replaced in armature bearing in December.

Car "No. 6":—Placed in service Oct. 12, 1890; No. days, 52; average miles per day, 118 31-52; total miles, 6,167. Repairs, none.

Hartford Electric Light Company.—The directors of the Hartford Electric Light Company, have re-elected A. C. Dunham, president, and H. M. Clark, secretary and treasurer.

THE ELECTRIC ARC AND ITS USE IN LIGHTING.[1]

BY ELIHU THOMSON.

It is curious that notwithstanding the fact that as a source of illumination the electric arc has been known since the beginning of the century, the scientific study of its nature has been but little pursued. It began to be known as a sort of scientific curiosity, being at first set apart as one of the many phenomena observed in the use of powerful batteries. It was not until about twenty years after its discovery by Sir Humphrey Davy that any proposals were made to use it in lighting, and, subsequently, for many years it was occasionally employed either in lecture demonstrations or in obtaining an intense light for some special purpose.

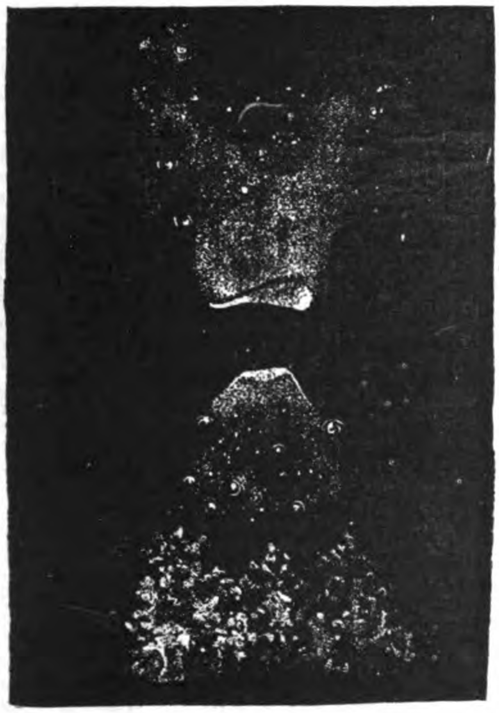


FIG. 1.—OLD REPRESENTATION OF ARC CARBONS.

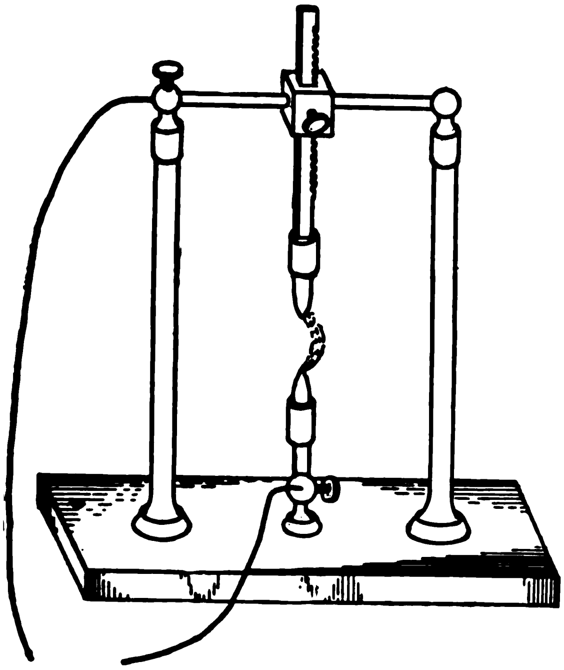


FIG. 2.—OLD FORM OF ARC LIGHT.

The efforts to use it in lighthouses led to the designing and construction of machines on the magneto-electric principle to replace the cumbrous and costly batteries otherwise required. I remember vividly the hours of labor and time necessary to prepare a battery of forty Bunsen cells for use in working a single small arc light for, at most, two or three hours. But I remember far more vividly the suffocating fumes and risk of acid spilling, with accompanying ruin concomitant on the taking down of a partially exhausted battery. Even to work with the arc for an hour or two was, however, adjudged a sufficient compensation for the disadvantages in obtaining the current. All this has, however, been changed, and the past ten or fifteen years has made the arc as a source of illumination one of the indispensables of a progressive community. Instead of the original, little short sticks of wood charcoal used as "points," which were only "points" because it was not expected that the arc would be burned for more than a few minutes without exhausting the battery, there came later on the little hard carbon sticks about two inches long and 3-16 inches square, sawn from hard gas-retort carbon, or from battery plates; and, lastly, came the moulded and forced carbons made from a paste in a powerful press, millions of which are now required every week to keep the lamps at present in use supplied.

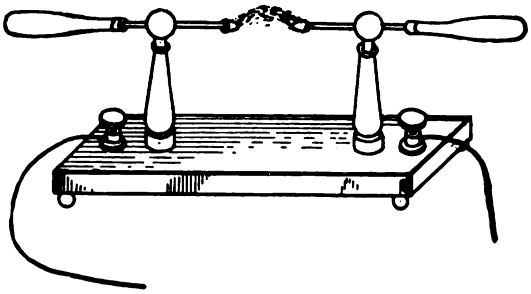


FIG. 3.—OLD FORM OF ARC LIGHT.

The charcoal points of Davy were touched together horizontally after attachment of the wires to the battery and were then separated. The stream of hot flame which followed or joined the points being deflected by air currents took the form of an arch or curve which gave the name to the phenomenon. Even with one carbon directly over the other, the curved form of the stream is the rule when the carbons are widely separated. Davy's original experiment was made with a battery of 2,000 cells, with zinc and copper plates about six inches square, the exciting fluid being very dilute sulphuric and nitric acids.

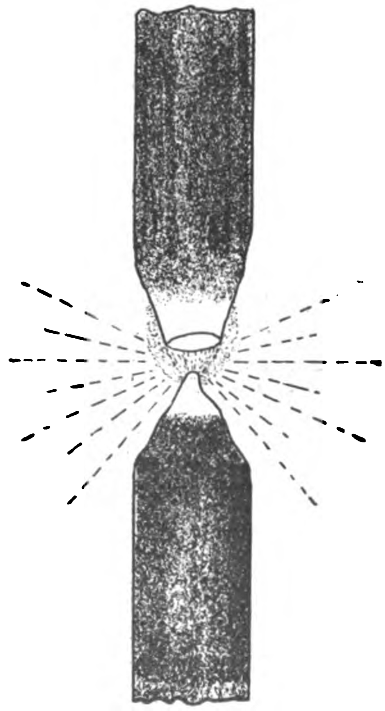


FIG. 4.—THE MODERN ARC LIGHT.

Davy's description is as follows: "When pieces of charcoal about an inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch) a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and, by withdrawing the points from each other, a constant discharge took place through the heated air in a space equal at least to four inches, producing a most brilliant ascending arch of light, broad and conical in form in the middle." This was evidently a long, flaming and horizontal arc. I find this form shown in a book published as late as 1846: Davis' Manual of Magnetism. Indeed I know of no more forcible example of the persistency of old ideas than is afforded by the accounts given in the books concerning the nature of the electric arc. The persistence of old cuts is also equally exemplified, even down to the latest publications, giving pictures of the electric arc. The carbons are generally shown crusted over with dense masses of impurities melted into globules and adhering to their sides (Fig. 1). Such figures would not now be recognized as resembling arcs formed with good, pure carbons, such as must be used for commercial results in arc work.

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[1] Read before the National Electric Light Association, Feb. 18, 1891.

Figs. 2 to 4, inclusive, show the development at least in illustration concerning the electric arc.

Fig. 2 is from Davis' Manual, referred to.

Fig. 3 is one of the figures showing the arc, taken from Ganot's Physics, published in 1863, though the figure is from the 7th edition, 1886. It is virtually the former figure made vertical.

Fig. 4 is a figure of a modern arc.

In regard to the ideas put forward as to the nature of the electric arc there is even a wider divergence than in the figures used for representing it. But these views are remarkable for their general inaccuracy or crudity and evidently have been handed down with modifications. Few of those who have written about the electric arc, at least in the text-books, seem to have had the courage to look at the arc, or they may have seen it "through a glass darkly and not face to face." It would require too many and lengthy quotations to give these various views. In most of them the light of the arc is attributed to intensely heated carbon particles transported by the current from one pole to the other. In most of them the idea of carbon vapor as a possible factor never seems to have arisen. Others attribute the arc to the heated air between the carbons which carries carbon particles, some of which are burned.

The following quotation from a book on electric lighting, published in 1884, is a type of many such accounts:

"In arc lamps, as we have already stated, the resistance which converts the current into heat is that of the heated air between the ends of two carbon rods, from one to the other of which the current passes. The light is produced by the incandescence of the ends of the carbon poles, and of the minute particles of carbon which become detached and float in the heated air between them. The heated air containing the particles of carbon forms what is called the electric arc."

Here the heated air and carbon particles floating therein are definitely stated to form the "electric arc." Nothing is said of carbon vapor having anything to do with it.

Even the statement that the positive carbon burns twice as fast as the negative is very frequently found unqualified in any way whatever. The experience of the lamp trimmer is, I need scarcely say, not in accordance therewith, the fact being that the rate of consumption even in direct current arcs with the same size carbon in both holders varied sometimes quite widely from the proportion stated. However, we shall make better progress if we discard at once the older notions, and, adhering only to that modicum of truth which often accompanies error, supplant the error by the results of our own observations and experiments. My endeavor, will, therefore, be to state as briefly as I can such views of the nature of the electric arc as seem to be borne out by observation during many years, and under greatly varying conditions of its production.

Let an attempt be made to separate any part of a circuit in which the current is maintained by a sufficient E. M. F. or potential, and we find that if the separated ends are moved quickly we get a flash or spark of varying length which becomes a flame of great heating effect if the current be of large rate of flow. If the separation of the two parts of the circuit be made slowly a continuous flame or discharge will take place between the ends if they be not too widely separated or not so widely separated that the potential or pressure of the current is insufficient to force current across the space. With considerable potentials and heavy currents a space of many inches may thus be bridged. Whether the separated ends be of iron, copper, carbon, platinum, zinc or other conductor, the hot discharge is still formed. Therefore while the electric arc is generally spoken of as that flux occurring between *carbon* ends separated, of course it can not be so limited and we frequently, therefore, refer to copper arcs, iron arcs, carbon arcs, to distinguish one from the other. What then is the arc so formed? Is it heated air between the ends separated containing detached particles of the conductor in process of carriage, as was apparently thought for a long time to be the case? No, the arc proper is composed of a stream of vapor arising from the actual boiling or vaporization of the solid or fused ends of the separated conductors. In so far as the surrounding air mixes or combines with this vapor stream it is modified by the presence of oxygen and nitrogen, but the air or any other gas is not essential to be present and is merely incidental to the formation of the true arc stream in air. Indeed it may seem strange to some to speak of vapor of carbon, copper, iron, platinum, etc., but their production is merely a question of temperature in any case. In the electric arc there is a real distillation of the conductors forming it and this accounts for the variation of color and temperature to be found in different arcs. The copper arc evolves a peculiar green light which is exceedingly trying to the eyes as those who have experienced its effects well know. Zinc gives a whitish blue, while the carbon arc proper is purplish in tint. The arcs from various metals give in the spectroscope the characteristic lines of the vapor of each metal.

As a curious incident, showing the presence of the metal vapor in the arc, I may mention the fact that when by accident a person has had a portion of his clothing bathed for an instant in a heavy copper arc caused by a short circuit of heavy current mains there has been found a considerable deposit of copper, enough, in some cases, to give the reddish color of copper to the surface bathed, which, if moistened, turns green by oxidation. It also gives a deep blue to dilute ammonia in which it is washed, thus showing the presence of copper. In like manner these metallic arcs will give a deposit of the metal on cold surfaces which they touch.

It appears to be the positive pole which gives out the vapor stream. With carbon the positive vaporizes steadily and is consumed much faster than the negative. In the use of the arc, however, for lighting we have learned to distinguish between what is called a "short arc" and a "long arc" system. In short arc systems the carbons are burned much nearer together than in the "long arc" systems. Let us suppose the case of two carbons touching each other with a current passing and then that we very slowly separate them, stopping to observe effects. When the contact is light before actual separation, a visible heating of the meeting ends is seen. On attaining a small separation the space between seems filled with hot vapor and we have a short arc where the separation is perhaps not over 2 to 3 one hundredths of an inch. There is also noticed an active transfer of carbon from the flattened end of the positive and a deposition of carbon on the end of the negative carbon. This deposited carbon takes the form of a mushroom end after a time, and breaks off. Meanwhile combustión goes on at both poles and wears away the sides of the positive carbon while the transfer of carbon wears away its tip or crater. The burning also wears away the negative at the sides, while the tip is built up by the mushroom deposit from the arc. But the cutting in of the negative finally severs the mushroom tip and it falls away. Hence both carbons are eventually consumed. To develop a short arc there is required a little over half the potential that is needed for a "long arc," or about 25 volts more or less, and therefore to give out equal heat energy in the arc the current must be double in the short arc over what it would be in the long arc. The short arc is subject to the objection of a continual frying sound emitted and great variations of luminosity; it requires a very dense and hard carbon to conduct the current without great loss, and involves line loss of at least four times the amount with the long arc if equal gauge wires be used.

In fact, while in the past such arcs were common, their number is diminishing, as they are being replaced by the more efficient and completely developed arcs called "long arcs," which are so called to distinguish them from the "short arcs." Returning to our separating carbons we find that as the space of arc is lengthened from the short arc condition, we pass a stage of great flickering and unsteadiness and a fluctuating potential between the carbons, and then reach the stage of production of the long or quiet arc. With ten amperes the separation may now be about 1-16 to 1-10 inch or more. Smaller currents require less separation and larger ones an increased separation. At this stage the arc is quiet, with good pure carbons very steady, and the potential difference remains at about 45 volts, if, of course, the carbon is properly fed to make up for combustion. The perfect arc is really a beautiful phenomenon. While the positive carbon still loses by volatilization from its tip or crater and by combustion from its sides, the negative gains no deposit but wastes at a less rate than the other, and by combustion only. The carbon vapor carried off from the positive is consumed by the oxygen of the air before it can deposit on the negative. Hence the outer zone of flame, which can easily be distinguished from the central zone or arc flux proper, is probably a zone of combustion similar to that existing in ordinary flames. The removal of carbon by vaporization from the positive end, gives rise to the crater or cup which is so prominent a feature of carbon arcs produced by continuous currents. The size or area of the crater is a rough measure of current strength but varies with different qualities of carbon. With very long arcs the crater or hollowed end disappears and the ends become rounded. A well formed crater with the arc or flame confined thereto means usually a steady light, since the chief source of light in an electric arc is from the positive crater which shines like a diminutive sun and represents the hottest part of the arc. The vapor light proper, or flame light, is comparatively very feeble and of a purple quality in air. Hence the arc light is as truly an incandescent source of light as is the incandescent carbon filament, with the difference that to run the latter at the temperature of vaporization or boiling point of carbon, so to speak, means instant destruction, while by the necessities of the case the light obtained from the arc is chiefly that emitted from a surface of carbon at its temperature of boiling, or more correctly of sublimation at atmospheric pressures. This temperature is exceedingly high, and accounts for the well-known superior economy in light production of the arc over all other kinds of lighting. The temperature of the positive carbon crater is so high that the carbon exists there in a soft or plastic condition capable of receiving an impression like putty. I have proved this with very large arcs of 150 to 200 amperes by suddenly forcing the carbons together when the current had been cut off and finding that they would fit each other perfectly, the negative impressing its form on the positive crater.

As an interesting fact in this connection I may state that I have been able to bend carbon sticks of 3-16 to ¼ inch in diameter by passing current through them of sufficient amount to almost vaporize the sticks and cause them to emit an intensity of light approaching that of the arc.

These facts would point to the possible fusion of carbon into liquid carbon at arc temperature under a high pressure of inert gas. No one has as yet seen carbon in this liquid condition, and the electric arc alone has made us acquainted with carbon vapor. One cannot fail to be impressed with the fact that the conveyance of carbon in the arc has a striking resemblance to a plating process where metal is taken up by the bath from the positive plate and deposited on the negative. In the arc the hot vapor stream or flame takes the part of the bath and probably acts by molecular interchanges of carbon atoms in molecules of carbon to cause the transfer which occurs, just as in the plating bath the molecules of the plating compound are polarized and allowed atomic interchange which results in conveyance of metal through the bath.

Another curious fact in relation to the arc is the distribution of potential in it. Dr. J. A. Fleming has recently shown that the difference of potential between the positive carbon and the arc flame is about forty volts, and the few volts which express the difference between the flame and the negative make up the total potential, say, forty-five volts. Hence the real work of the arc is not in the flame; the energy is not used in overcoming flame resistance but chiefly in vaporizing carbon in the positive crater. It is certainly not strange that with forty volts, and, say, ten amperes or 400 watts expended virtually at the crater surface of the positive carbon the temperature and luminous effects should there be so great.

The distribution of potential in the arc just noted was also brought out about the year 1884 in some testimony in an interference in our patent office concerning an arc lamp cut-out which I had invented, and which took advantage of the potential differences between the carbons and the arc flame to cut out the lamp when the arc was too long. It is of course well known that the value of an arc light for general illumination is greatly enhanced by the fact of the distribution of light being mainly in a downward direction in continuous current arcs. This of course follows from the fact of the positive carbon crater being above, such crater being the part from which most of the light comes.

This matter has been quite thoroughly investigated and many diagrams of distribution are to be found in the literature of the subject as published from time to time. They show that with the long arc the maximum intensity of light is from 40° to 60° downward from the horizontal, and that the horizontal intensity is generally much less than one-half as great, while of course the intensity diminishes above the horizontal direction and ultimately becomes zero before reaching the upward vertical direction. In like manner the approach to the downward vertical from the direction of maximum intensity is attended with similar rapid diminution.

The spherical candle power of arc lights would therefore be only a fraction of the rated candle power which is generally taken at the maximum light obtainable in the best direction from the particular arc or kind of arc in question.

For this reason the term 2,000 c. p. arc has little significance as indicating the illuminating power of an arc. It is a convention only and a poor one at that. It is now generally taken to mean an arc with ten amperes and not less than 45 volts potential difference between the carbons, or a 450 watt arc. The quality of the carbons will determine whether the 450 watts will be expended in obtaining the most light or not, or whether that light will have a maximum intensity at one angle or another within certain limits.

When arcs are operated on by alternating currents, the effects mentioned are only partially exhibited, and the phenomena of the crater are of course masked or obliterated on account of reversal of function of the carbons. Unless the alternations are rapid, such arcs are liable to extinction at the zero points of current, particularly when run in a draft of air. A strong draft of air or a displacing magnetic field may of course so disturb an arc as to cause its extinguishment.

In the early years of the growth of arc lighting as a means of illumination, the effects obtained were not of the best. Unsteadiness was the rule, and it required much persistent effort to discover the causes and find the remedy.

The prominent defects were, and, we may add, are still, hissing, sputtering, flaming and general unsteadiness. Hissing or frying comes of course with too short an arc and may be connected with too vigorous vaporization. They may also be due in some cases to a carbon of too coarse a grain. Sputtering may arise from impurities in the carbons, and flaming from too long arcs from impure carbons, or from carbons insufficiently baked and containing unexpelled gases. Running an arc at a length between the long arc condition and the short arc condition may cause great unsteadiness of light. There is, in fact, a critical point in the length below which there is a considerable fall of luminosity and a drop of nearly one-third of potential. As an arc lengthens by combustion of its carbons beginning below this critical point, great unsteadiness will be manifest on arriving at the critical state and a little longer arc brings about a sudden and very marked increase of potential, of illumination and of steadiness.

Any observer may easily detect these conditions without special effort. The earlier carbons used with arc lamps in the United States were both badly conducting, impure, and badly made. Copper coating was a necessity. French or Carré carbons were much better, but were too costly to import. The use of the petroleum carbon or the carbon obtained by the carbonization of the tarry residue left in the distillation of crude oil, made a wonderful difference in the purity of the carbons, and improved machinery gave accuracy of form and cheapness. To one familiar with the former cost of carbons for battery arcs the reductions in cost are very striking: carbons 3-16 inches square cost a number of cents an inch before the year 1878.

Another important matter in relation to carbons is that the size of section or diameter must be proportioned to the current used. Where attempts have been made to prolong the hours of burning of a carbon by enlarging its diameter beyond certain limits, they have resulted in injury to the character and distribution of the light. Large diameters of carbon may burn too blunt to let the light out between them.

Likewise, where attempts have been made to prolong the hours of use by employing a harder or denser carbon than before, it has frequently been found that a sacrifice of light has been incurred, rendering the results much less satisfactory.

One of the chief obstacles to the employment of quite small arcs with currents of three or four amperes is the difficulty of obtaining suitably uniform carbons.

Arcs of even as low as two amperes at 45 volts are easily produced and such small arcs might even have commercial utility if the difficulties in relation to carbons were removed. An arc consuming 90 to 100 watts means of course about 7 or 8 to the electrical horse power.

On the other hand, very large or heavy current arcs are difficult to control. They are apt to be unstable at times, and when they get to hissing, or rather roaring, it is difficult to restore quietness and steady action. The introduction of cored carbons for the positive, has, however, done much to remedy the difficulty, and indeed to render it possible to obtain very uniform results from arcs in general wherever such results are indispensable. The introduction of the central soft core into the carbon seems to locate the arc centrally, hold it from fluttering or shifting its position on the end of the positive; in other words, the core fixes the position of the crater, and so benefits the light.

It follows from the fact that the voltage required to sustain an arc with large or small currents ranges about 45 to 50 volts that the larger the current passing in an arc, the less its electrical resistance. Hence well developed arcs with 4 amperes will have about 11 oms, with ten amperes 4. 5 ohms resistance and with 100 amperes .45 ohms. This fall of resistance with increasing current is easily explained by the broadening or thickening of the arc stream, and the widening of the crater on the positive carbon. This widening of the crater also gives increased illuminating power without increase of temperature. It is probable that the actual crater temperature is as great in the small arcs as in the large ones. In fact, this is implied by the quality of the light remaining the same. Nevertheless the larger the arc the greater the economy or the greater light giving power per unit of energy. This would naturally be expected as the concentration of heat and lessened chances for escape of heat by convection and conduction would conduce to that result.

The fall of resistance with increase of current has an important bearing on the construction of dynamos for arc lighting and the running of lamps on constant potential or incandescent circuits; and will be referred to later on. Attempts have been made at various times to save carbons in arcs by excluding the oxygen of the air which is the cause of their waste or consumption by burning. The gain has not apparently compensated for the disadvantages incurred, particularly as the total exclusion of oxygen means that the carbons become blunt. They would be prevented from pointing themselves or acquiring tapered ends by burning, a condition essential to good working and distribution of light. Even when the arc is formed in a vacuum the carbons, though not burned, are slowly consumed, and carbon deposited as a soot on the sides of the vacuum chamber, an effect consequent upon the vaporized carbon in the arc being carried off and condensed again as soon as the vapor escapes the heat of the arc stream.

In fact, I have found it possible to coat objects on the inside of a bulb with silver or other metals volatilized suddenly by arcs in vacuo, and have obtained in some cases coherent brilliant deposits. The metal is raised in vapor as a metallic arc and distills and condenses on the surfaces near at hand.

Before passing to the consideration of the running of arc lamps in series, or in multiple; and the condition to be fulfilled in each case, we may state that although in ordinary cases an arc is formed by a single pair of electrodes or carbons, and by a single circuit current, compound arcs, or arcs produced by combinations of two or more currents with three or more electrodes, are possible. I am not aware that any others than myself have experimented in this direction. I have, however, produced lights with two positives and one negative, with one positive carbon or crater and two, three or more negatives and with two positives and two negatives. I have caused arcs to cross each other, as when four carbons are used, pointing towards a centre, the two pairs opposite being respectively connected with different circuits. In this way direct arcs have been, as it were, mixed with alternating arcs and a curious compound effect produced by crossing two arcs made with two alternating currents the waves of which are displaced in phase. Without going fully into these experiments I will present figures showing two good examples. Fig. 5 is formed by two currents sent into a positive P and dividing, after passing the crater, into two streams going to the two negatives. In this case the positive crater is fully exposed horizontally and gives a most intense light in a direction forward. Such an arc is well adapted for projection by mirrors or lenses.

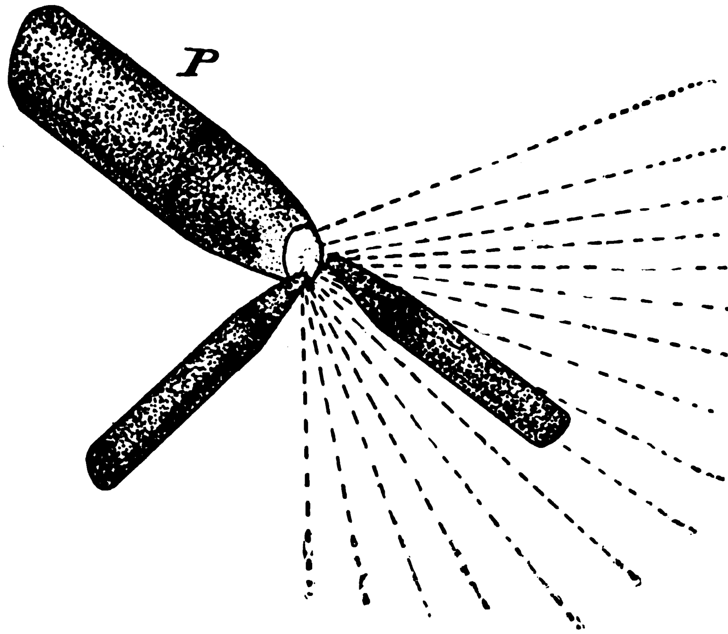


Fig. 5.—Arc Formed Between One Positive and Two Negative Carbons.

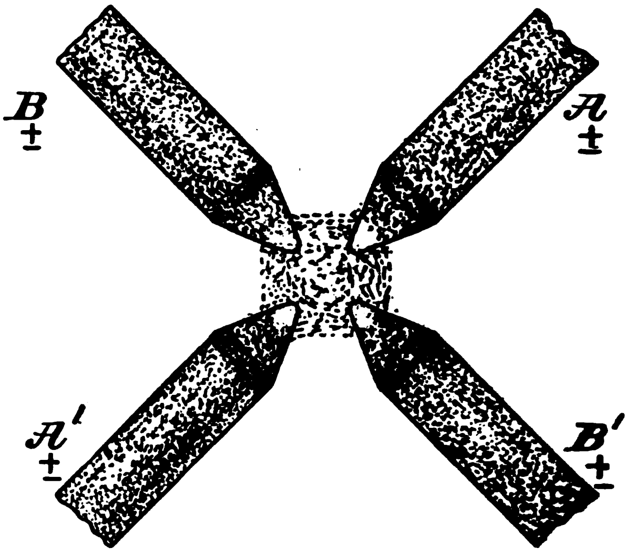


Fig. 6.—Arc Formed By Crossing Two Alternating Currents Out of Phase.

Fig. 6 shows the arc formed by crossing two alternating currents out of phase. In this case there is at successive times an exchange of current between all four carbons in varying directions so that the arc flame becomes, as it were, a ball or disc of very hot flame supported by the four carbons. These experiments have not been fully described as yet, owing to the lack of time, but they show very well that even when we have fully studied the single, simple arc, we will not then have exhausted the subject as these compound arcs may be varied in character to a great extent and present new effects.

In regard to that portion of our subject which concerns the use of the electric arc for lighting, it is true that there is a wide field before us. I cannot hope to do more in this paper than to outline, in addition to the considerations already alluded to, some of the other prominent features of the subject. It is well known that by far the larger proportion of electric arc lights in operation is run on circuits of constant current, the lights being in series.

If arc lamps be connected in parallel, as on low potential incandescent mains, special devices are required to keep the current supplied to each lamp at the right amount.

It may appear at first to one who has not had occasion to closely study these matters that, given a constant potential circuit of fifty volts, arc lamps requiring fifty volts could be connected in multiple or parallel without difficulty. The fact is, however, that the condition of electric arcs being supplied with a constant potential involves a theoretical impossibility. Theoretically, such an arc would take an infinite current and energy. Practically, the current in an arc with constant potential becomes very heavy and if the carbons be separated to cut the current down, as by a lamp magnet mechanism, a condition of fluctuation and instability results. This is a direct consequence of the fact before stated that the resistance of an arc is not like a wire resistance but falls with increase of current, and vice versa. For stability the resistance should not be dependent wholly on the current passing. To remedy the instability a resistance known as a "choking coil" or "sluggishing coil" is inserted in the arc branch and the potential raised, say, to 65 or 70 volts. Under these conditions, that is with a resistance taking up 15 to 20 volts, in series with the arc, it may be run in multiple with incandescent lamps or with other arcs. There is, however, a waste of energy equal to the product of the current strength by the loss of potential, 15 or 20 volts, in the resistance. A great deal of useless experimenting has been, and probably is yet, carried on with the vain endeavor of getting rid of the resistance or choking coil in this case, but the difficulty is inherent in the nature of the arc, the relation of resistance to current giving rise to instability of current in the arc.

Similarly, not all dynamos, even if of sufficient potential, will run arc lamps in series. Arc machines require special properties or the current will be unstable and the light will fluctuate or "surge" as we sometimes call it, possibly to an extent amounting to extinction and relightings occurring at short periods apart. This action, like the other, is dependent on the relation of current and resistance as inherent in electric arcs, and the series of lights would in each case require dead resistance up to a certain amount in circuit to render the current stable. Then, whether a series be operated or a single arc be operated, either a dead resistance must exist in circuit or the current supplying apparatus must have special properties. The arcs produced from batteries were stable because the resistance of the battery itself was sufficient to ensure this. Arcs are not stable as fed from accumulators of very low internal resistance unless the arc is one of enormous current.

Briefly, the property required to be possessed by an arc dynamo is that as its current rises above the normal the electromotive force must fall, and as the current dimishes to a little below the normal the electromotive force of the dynamo must rise. It is not sufficient to secure this changing E. M. F. by regulators, as they are generally behind time for causing stability of current, however well they may operate to regulate for varying numbers of arcs in the series to be supplied.

The properties of dynamos are sometimes expressed by what are called "characteristics," or "characteristic curves," obtained for example by laying off vertically, or on the ordinates, the electromotive forces corresponding to varying currents given out by a machine, which currents are laid off horizontally, or as abscissas. In arc machines the curve so produced is convex upward and droops at its outer end *b*, Fig. 7. Assuming normal current at 10 amperes and an E. M. F. of 500 volts, at 11 amperes the E. M. F. may have fallen to 420 volts and at 9 amperes risen to 530. We would then be working on the "droop" *a* to *b* of the curve when at 10 amperes; and such a machine is stable as to current for running arc lamps. There appears to be required not merely a droop in the curve, for securing stability, but more than a certain amount of rate of droop or dip. If the line could be made to droop or dip vertically after passing the normal current the machine would regulate without a regulator or be a constant current automatic machine.

In what respect then do arc dynamos differ from others to produce this relation of droop in the characteristic curve? Without doubt the effect is mostly due to the reactionary effects of the armature on the field, which effects in arc machines are made greater than in others, and the field magnets meanwhile are frequently saturated magnets, so-called, and not greatly sensitive to the current in their coils. The armature of an arc machine is indeed so powerful an electro-magnet that it is able to control the magnetism of a portion of the field in which it turns. A sort of balance of magnetic forces is established at certain portions of the field which on an increase of current in the armature produces polarity opposing the field polarity at the portions mentioned, such as will cut off some of the lines of magnetism from entering the armature core and so lower the electromotive force; while a lessened current in the armature will weaken its polar portions and an increased number of lines will enter the armature core from the field and so increase the electromotive force at the brushes of the commutator. In Fig. 8 the portions at K K are those at which the balance or conflict of opposing poles of armature and field magnet exist, namely, at those portions near the diameter of commutator or position of the brushes on the commutator.

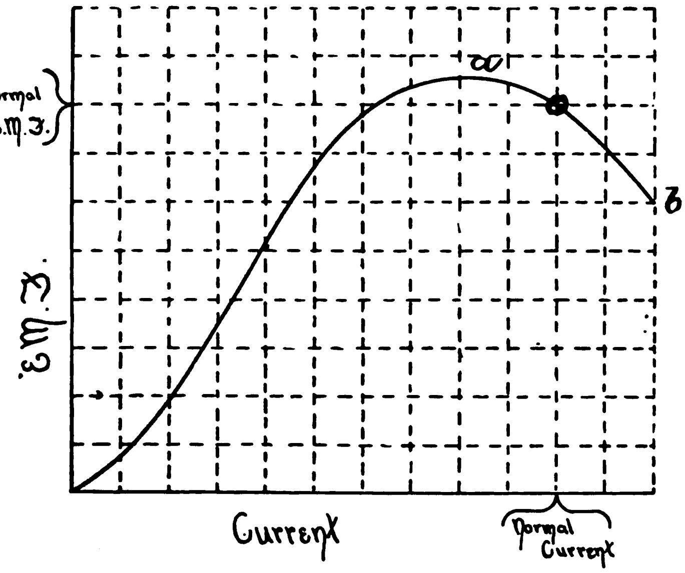


Fig. 7.—Characteristic of Arc Light Dynamo.

Could the droop or fall in the characteristic curve be made a vertical as stated before, then we should have a self-regulating machine not needing a regulator to preserve a constant current under all loads. This condition is more easily arrived at in alternating machines, one of the first, if not the very first, example of which is found in the Chertemps-Dandeu machine which was tested by Robert Sabine, as described in Dredge's "Electric Illumination," vol. 2, 1885. This machine had the remarkable property of permitting ten arc lamps to be cut out or put into its circuit in series in any way without causing a variation in current strength of more than ten per cent. The interactions occurring between the armature and field accounted for this regulating property. In these cases the armature currents react upon the field with a force producing at times a balancing of magnetism between the two. The distortive power of the armature upon the field is made very great, which amounts to the same thing.

In the recent alternating machine for constant current brought out by Mr. Wm. Stanley we have an excellent example of the application of similar principles of construction, together with the difference that the arc lights which were fed direct in series from the Chertemps-Dandeu machine, are run from transformers with the primary coils in series in the Stanley apparatus.

The relation of current to constancy is, however, in continuous current dynamos for arc lighting, generally effected by regulators as they are called, which so alter the dynamo on a slight increase or decrease of current as to raise or lower its electromotive force according to the resistance in circuit, or speed.

In one form of regulator the effect is obtained by changing the field magnet strength by automatic mechanism, weakening the field when lamps are cut out and strengthening it when lamps are added to the circuit. Another means of regulation is the rotation of the commutator or brushes so as to take current from positions corresponding to increased or decreased electromotive force in such a way that the current obtained is constant. The former method first appeared in the Brush arc apparatus and the automatic commutator brush movement in the Thomson-Houston machines. The latter method renders the machine completely automatic under variations of load while in the former there still is required a manual spark adjustment of the brushes as the field magnet is altered in force under different loads. The two methods were subsequently combined by the writer in conjunction with Mr. E. W. Rice, Jr., in such a way that the necessary brush adjustments were made automatically at the same time with the variations of the field under different loads. This combined method has been used for some time past in the Excelsior machines constructed under the patents and designs of Mr. Hochhausen, whose name is so well known in connection with arc lighting and plating and other electric apparatus in this country. On account of the fact that with the addition of arc lights in a series a higher and higher potential difference is required at the terminals of the dynamo, it becomes a question how far this increase may properly be carried. It is not unusual in the present practice to run from fifty to sixty lights in a series, each demanding from forty-five to fifty volts, or a total of, say, three thousand volts. In going beyond this amount the difficulties of insulation are greatly increased, as well as the dangers of high potentials, while the consequent risk of breakdowns resulting from failure of insulation or leakage are often sufficient to offset any saving of wire conductor that might be obtained by running more lights in series. Instances have occurred in which with ordinary wiring and precautions, 120 to 150 arcs have been run for days together, but such a practice is to be condemned as involving hazard of all kinds.

It has been supposed by some electricians that there existed a peculiar fitness for arc lighting in series in dynamos of the open coil type, such as the Brush or Thomson-Houston, over those of the closed coil types, such as the Gramme or Siemens forms. Whilst, personally, I have never been prepared to admit this peculiar fitness, constructors of machines of the closed coil types have certainly succeeded in removing any doubts on that score. Mr. J. J. Wood has, in building his form of Gramme machine up to the highest capacities for series work, taken a leading position in this respect. In fact the simplicity of the commutator and the ease of insulation of machines of the open coil type undoubtedly rendered them more capable of retaining insulation at high potentials than the early commutators with numerous segments used on Gramme and Siemens machines, as such commutators were at first constructed. Likewise, improved methods of insulation and winding have gone far to put both types of machine far in advance of what they were formerly. While on this subject of arc machines it may be well to say a few words as to the action of flashing which can occur in all machines of high potential under certain conditions. In the first place the term flashing, as here used, is not intended to refer to sparking at the commutator, but rather to a flash or continued spark carried over during revolution of the armature from one brush towards the other, either all around the commutator or part way only. This action occurs when any two successive segments in the commutator continue their discharge one towards the other over the insulating space between them during a considerable part of the revolution. An arc forms in the slots or between segments and moves with them. This action, while not very damaging where the segments are massive and insulated with air spaces, is more serious with insulation filling between the segments, as it is apt to cause a burning out and either short circuits the armature coil sections by connecting the segments, or seriously roughens the edges of the segments and the face of the commutator.

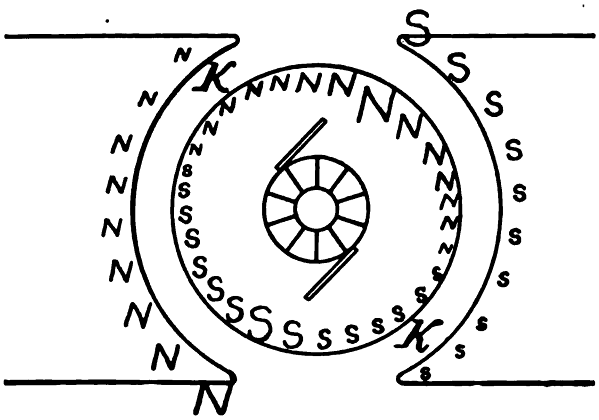


Fig. 8.—Distribution of Magnetism Between Armature and Field.

Bad setting of brushes may cause both sparking as well as flashing; and dirt, in some cases, or too much oil, may cause it.

Slipping of belts or sudden fluctuations of speed may also provoke it. Or a machine, overloaded, may flash by an opening of the circuit due to too many lamps, the electromotive force required for which number the machine can not maintain. The presence in a circuit of one or more lamps which do not feed properly may cause momentary cessations of current and flashing to occur, especially when the machine is carrying its full load. With all arc circuits there should, of course, be a surplusage of capacity in the dynamo, *i. e.*, the machine should not be run to the limit of its electromotive force. It has become customary with the best makers to so rate this capacity that there will always be a margin of excess to meet contingencies. The line resistance may, of course, be, in the case of long circuits, such as to cut down to a considerable extent the working capacity or number of lamps in series which can be run from the dynamo, and due allowance should always be made for this resistance in estimating the true capacity. Instances are not uncommon in which by improving the contacts of switches, hangers, joints, etc., a gain of two or three lamps may be made in circuits of fifty or more lamps in series. An improvement in the insulation of a line will often have a similar effect in adding to the apparent capacity.

I had intended at the outset of this paper to discuss in a general way the question of the different types or classes of lamps used for arc lighting. It is a department of the subject which is of considerable importance, but I find that the paper has become too long already, and for the present I will simply allude to one or two general features. Concerning the manner of feeding the carbons the mechanisms in use may roughly be divided into clutch and gear mechanisms. Among clutch mechanisms we find certain well known forms while the gear mechanisms best known are of the escapement order. Both types have undergone many modifications, and combinations of the two exist.

Whether one or other type is to be selected will depend largely on the conditions of use, assuming both to be equally well constructed and kept clean. Into these questions, however, we can not now enter.

Arc lamps may also be divided according to the way in which the magnet system acts to control the feed of the carbon. Before arc lamps were run in series it was sufficient to have the controling magnet in the main circuit and this was the case in almost all the older forms of lamps. The Lacassagne and Thiers lamp of 1856 was a notable exception in that the control of the feed was differential, or dependent on the difference of power between a main circuit coil and a high resistance shunt circuit around the arc.

I have, in fact, made an exact reproduction of the Lacassagne and Thiers lamp according to their patent specification and have found that its action is perfect when used in series with other lamps, except that it requires to be helped to separate its carbons. If the carbons are quite pointed at the start even this is unnecessary, as the points soon heat and burn away and form the arc. The feeding depends on the flow of mercury through a small valve which is adjusted by the differential magnet system, and the feeding is so continuous and imperceptible that the arc is beautifully steady and constant in length.

At the present time the differential lamp magnet system is of several kinds, according to the relative disposition of the main and shunt coils.

In the commercial Brush arc lamp they are disposed one over the other on the same axis and affecting the same magnetic cores. The only objection to this disposition, which has the advantage of simplicity, is that the shunt circuit can never act positively to feed the carbons or release the clutch or gear, but can only weaken the effect of the main coil or overpower its lifting or separating action on the carbons.

Other forms of differential lamp embody two circuits acting on separate magnets pulling in opposite directions, the main circuit to separate the carbons and the shunt to feed them. In this case the action of the shunt is more definite and positive, as it is not limited simply to overcoming the force of the direct or main magnet.

A third arrangement involves the application of the repulsive action of the two coils, as when the direct coil is wound on a fixed magnet, and the other, or shunt, upon the feed controlling armature therefor and tending to cause repulsion of the armature from the main magnet. This arrangement is both simple and positive in its action.

The differential types of lamp act well when the circuit current is kept constant and require readjustment generally for each change of current strength by which they may be operated. Hence, if a portion of a line be leaky the lights are apt to burn badly owing to diminished current, while the dynamo may be furnishing full current. Of course such a line ought to be condemned and its insulation improved. Nevertheless I have frequently seen lights suffer from leakage on extended circuits in cities, especially in very wet weather. This is a state of things which the line superintendent can do more than any one else to correct, by attending to the correct disposition of the wiring, and its character as regards leaks.

The type of arc lamp in which the shunt magnet alone controls the feed of the carbons is not sensitive to slight variations of ent but maintains a full quiet arc with the current it gets. This is because the main current is not concerned in the feeding action, but the action is solely dependent on the potential difference of the carbons. Hence its behavior is on the whole more uniform than the differential type, and within limits it does not require re-adjustment for different current strengths.

This principle has been extensively introduced in the Thomson-Rice lamp of the Thomson-Houston Company. In this lamp the carbons are separate at the start and are brought together on the first passage of the current, after which they separate solely under the influence of the shunt circuit magnet and the feed is likewise controlled thereby. The carbons in these lamps are not so apt to slide by, or alongside, each other by jarring when no current is on the lamp, as may occur, particularly with careless trimming, in those lamps in which the full weight of the upper holder and carbon must be borne by the under carbon when the lamp is not lighted.

Arc lamps have been made with many variations in the magnetic arrangements controlling the carbons, a brief statement of some of which is as follows: Carbons lifted or separated by direct or main magnet; shunt magnet acting on a variable resistance to cut out the main magnet in feeding. Carbons lifted by main magnet as before and shunt acting to put the main magnet (made movable) into position for feeding.

Carbons separated by main magnet armature; shunt circuit magnet acting to divert or shunt the magnetism of the main magnet from its armature.

Carbons separated by main magnet and shunt acting to free the carbon holder independently of the support given by the main magnet.

Carbon separated by a spring and allowed to act by the main magnet lifting a weight which otherwise holds the spring from acting; shunt magnet acts against the spring to feed and regulate length of arc.

One carbon, generally the lower, separated by main magnet, while the other holder is released for feeding only, such feeding being under the control either of a differential system or a shunt magnet only.

Carbons separated by main magnet which lifts the shunt and its armature together, while the shunt magnet armature, acting on the feeding mechanism, controls the arc and feed of the carbons.

Carbon feeding mechanism independently attached to main magnet armature and to shunt armature, so as to receive opposite movements of separation and feed from each respectively.

Carbons separated by a feeding mechanism moved by the main magnet and fed by a further movement of said mechanism causing release or return of same under the accumulated force of both shunt and main magnets acting in the same direction.

Differential clock gear for separation and feed of carbons under control of the regulating magnet system either simple or differential. Some of the older clock-work lamps embodied this principle.

Carbons controlled by armature of a small electric motor under control of a differential field which turns the armature in one direction for separating, and in the other, or reversed, direction for feeding the carbons. Tchikoleff's early lamp was of this type.

Carbons controlled by a motor running at a certain speed when the arc is of normal length and varying in speed when the arc is too short or too long, combined with a centrifugal governor on the shaft of the motor acting on variations of speed to gear motor shaft to screw carbons together or apart, as needed, to maintain the normal arc. This mechanism has been applied by me to to large arc lamps such as naval search lights and has the advantage of great positiveness and an ability to handle heavy mechanism.

There are also a considerable number of modifications from these principles stated which cannot be referred to here.

Another excellent mechanism and one of the most powerful and positive in feeding the carbon, embodies a main magnet separating the carbons and striking the arc and an intermittently acting shunt magnet for working a pawl which, by a suitable gearing, forces the feeding action or approach of the carbons as required. I have used an endless screw gearing with the pawl acting on a ratchet wheel to turn the screw, the worm wheel being on a shaft carrying a pinion meshing into a rack on the carbon rod. The worm wheel gearing is lifted by the main magnet to strike the arc, and the shunt magnet in operating its pawl breaks its own circuit and repeats its feeding action as often as may be necessary.

It is interesting to note in this connection that I have built such lamps in which each feeding movement of the carbon is not over one-five-thousandth of an inch and that if the upper carbon rod is held in a vise the mechanism will lift the whole lamp of about twenty pounds weight in feeding, so positive is the action. At the same time the length of the arc is maintained constant at all times. With so slight and yet positive a feeding action the feed takes place almost continuously.

In the foregoing brief review many matters have been simply touched upon which might readily have been singly expanded into a paper as long as the present one. Material enough now certainly exists and could be collected, for making a good technical work dealing with the science and practice of arc lighting.

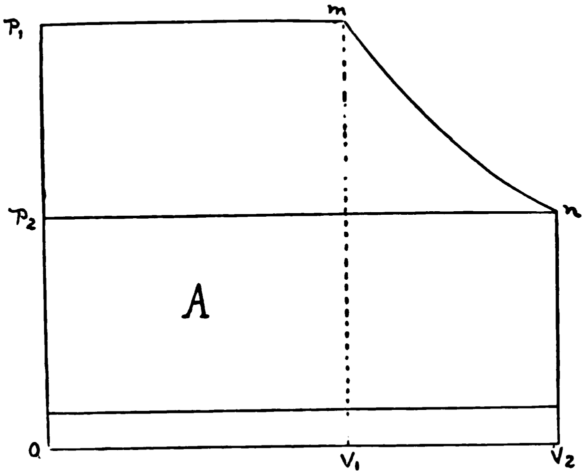
My purpose will have been fulfilled if I have succeeded in the present paper in adding some things of interest and instruction concerning this general subject from the standpoint of one who has constructed very many forms of apparatus for arc work, and who has had a continuous and growing experience with such work from its beginnings up to the present great commercial expansion.

DISTRIBUTION OF STEAM FROM CENTRAL STATIONS.[1]

BY F. H. PRENTISS.

WHAT has the distribution of steam from a central station to do with electric lighting? This question can be answered much after the Yankee fashion of asking another. What has coal-tar, ammonia, aniline dyes to do with making gas? These articles are bye-products in the manufacture, which were once thrown away as useless, but which have now a value hardly second to that of the gas itself. Is it not true that the exhaust steam of electric light engines is a bye-product in the making of light, and for heating purposes has a value scarcely less than the electric light itself? Since in a steam engine the amount of heat converted into work is relatively very small, the value of the bye-product or the exhaust steam is too large to suffer neglect. It is only a question of finding a market for it, and obviously this can only be done by a system of distribution from a central station. Will it pay to market this product? The answer to this question depends upon many complications and varied circumstances which in no two plants would be found alike.

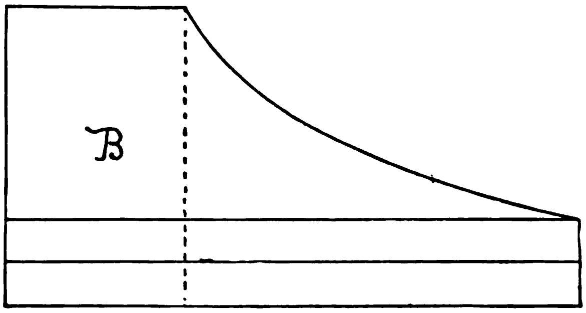
The history of commercial electric lighting covers hardly a decade. The same is true of the sale of steam from underground pipes radiating from a central station. In both of these enterprises, frequent failures have been met with and many lessons learnt. I believe it is a fact, however, that all present existing steam companies more than pay expenses. A few have paid dividends while many have been obliged to re-invest their earnings in improvements or remedying defects in original construction. The very few absolute failures have been due to faulty design, or defective engineering at the start. In the city of New York, two companies were started less than ten years ago, one of which, owing to faulty design, failed and gave up business; the other, known as the N. Y. Steam Co., is supplying steam for power and heating to nearly seven hundred consumers, and sells the product annually of more than 100,000 tons of coal burned under boilers aggregating nearly 20,000 h. p.



CYCLE OF CHANGES OF STEAM, CASE NO. 3.

In its distribution of steam through underground pipes the company has had many obstacles to contend with, the chief trouble having been the securing of absolutely tight joints. This difficulty has been completely removed by the method employed during the last four or five years, as is well attested by the network of pipes on Madison avenue and the adjoining streets between 53rd and 70th streets, where nearly three miles of pipe are in perfect operating condition and practically without a leak. The engineering difficulties which in an enterprise of this kind would strike one as more difficult to provide for, namely, the expansion of the pipe and the losses due to radiation, were most perfectly provided for at the start, and therefore, with the improvements which have been attained through practical experience of nearly ten years, the system has been brought to a state of perfection where in new work but little more can be desired. The pioneer work has been done and the electric lighting companies are therefore in a position to reap the advantage of the experience gained and to begin their work where the steam companies have left off, and can therefore feel certain in seeking for a market for their bye-product (their exhaust steam), to meet with no mechanical difficulties of construction.

The joining of two enterprises together, such as electric lighting and the distribution of steam from central stations, has both its advantages and its defects, and we must weigh one against the other. The electric light station is already in possession of its boiler house equipment, and for this reason has much less to charge up to the construction expense of steam distribution than a steam company, since its boilers are available for supplying steam directly to the street mains, when light is not called for or when the engine load is at a minimum, and can furthermore by proper adaptation deliver the exhaust steam from the engine into the street mains, and for the purpose of heating recover the larger portion of the original heat value of the steam. Again, in a combined plant the general expenses of management, superintendence and so forth, need not greatly exceed the cost for the same items in a single plant alone. An obvious disadvantage is the increased back pressure put upon the engines. I am assuming, of course, that the engines are of a non-condensing type. The prejudicial effect of this back pressure is a subject which will well repay a little study.



CYCLE OF CHANGES OF STEAM, CASE NO. 2.

Thirty pounds of water per h. p. per hour is the recognized standard of boiler capacity and is also a fair statement of the amount used by an engine of fair size exhausting into the atmosphere. A portion of the work of such an engine is spent in overcoming the atmospheric pressure of 15 lbs. per square inch, and when, therefore, in addition to the pressure of the atmosphere, an increase of back pressure is incurred, the useful work of such an engine is diminished by a corresponding amount. If this increase of back pressure is only that required for circulation of the steam for heating purposes, the increased consumption per useful h. p. per hour will not be greatly augmented in consequence, provided the pipes are sufficiently large and properly run.

The heating of residences by steam supplied from our 58th street station is often effected with steam at a pressure of one or two pounds. And it is well known that there are several systems in use where exhaust steam is applied for heating in a manner so as to make it possible to produce a vacuum in the heating coils. The back pressure of the exhaust, therefore, in a system where the engines discharge into street distributing mains, depends almost solely upon the size of the mains and the quantity of steam carried. A loss of pressure of 10 pounds in a half-mile of pipe provides a carrying capacity reasonably in accordance with the cost of the pipe. Of course if this difference of pressure exceeds 10 lbs., the cost of transportation becomes relatively less, while the loss at the engine becomes greater, and vice versa, in case the loss of heat producing flow of steam is less than 10 lbs. This, like many other details, must be determined upon in each particular case. In order to illustrate this point I will present some calculations based upon a back pressure of 17 lbs., absolute (about 2.3 pounds ordinary gauge) with an initial pressure of 92 lbs. absolute (or about 77.8 lbs. ordinary gauge pressure). We will call this Case No. 1.

For Case No. 2, let us take the back pressure at 30 lbs. absolute (about 15.3 gauge) and the initial pressure at 105 lbs. absolute (or about 90.3 lbs. ordinary gauge).

In Case No. 3, let the back pressure be 105 lbs. absolute, and initial pressure 180 lbs. absolute. The last case is interesting, since it called for a theoretical consumption of steam per indicated h. p. in an engine with an initial gauge pressure of about 165 lbs. and a back pressure of about 90 lbs. gauge. The diagram marked *A* shows the cycle of changes of steam used under the above conditions—omitting the practical considerations of wire-drawing, compression, early release and so forth, which are the interesting characteristics of an indicator diagram. The tremendous amount of unutilized work due to the excessive back pressure is clearly shown by the area of the rectangle P_2 V_2. In this diagram P_1 and P_2 are laid off as ordinates to represent the initial and back pressure, while V_1 and V_2 are laid off as abscissæ to represent the volume of 1 lb. of steam before and after expansion. The expansion curve *mn* is supposed to follow the law $P V^{\frac{17}{16}}$ = constant. The diagrams *B* and *C* represent Cases 2 and 1.

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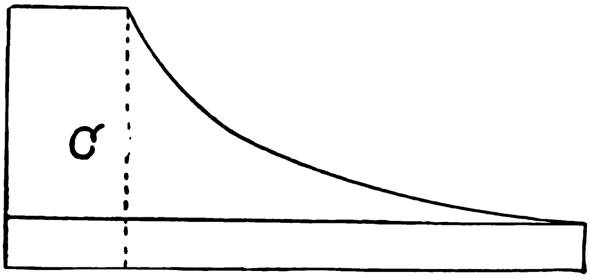
[1] Read before the National Electric Light Association, Feb. 17, 1891.

At pressure P_1 (180 lbs. absolute) Fig. *A*, the volume V_1 of 1 lb. of saturated steam is 2.49 cub. ft., and at pressure P_2 (105 lbs. absolute) the volume V_2 of 1 lb. of saturated steam is 4.14 cub. ft. Neglecting all cylinder losses due to condensation, leakage, clearance, etc., and supposing the expansion curve to conform to the formula $P V^{\frac{17}{16}}$ = constant, we have for the total work in foot pounds of 1 lb. of steam:

$P_1 V_1 \times 16 (P_1 V_1 - P_2 V_2) = 95645$ ft. lbs. Deducting the work of overcoming the back pressure ($P_2 V_2 = 62597$), we obtain, $95645 - 62597 = 33048$ indicated ft. lbs., and as 1,980,000 ft. lbs. per hour is equivalent to one horse power, it is evident that an engine working under conditions above-named would require $\frac{1980000}{33048} = 60$ lbs. of water per h. p. per hour.



Cycle of Changes of Steam, Case No. 1.

In a similar manner it may be shown that between the limits of pressure, 90 lbs. (105 lbs. absolute) and 15 lbs. (30 lbs. absolute), there would be required 26 lbs. per indicated h. p. per hour. This covers the case of an engine exhausting into low-pressure street-mains.

An engine exhausting into the atmosphere with 2 lbs. back pressure (17 lbs. absolute) and receiving steam at 77 lbs. (92 lbs. absolute) would require 19.7 lbs. of water per h. p. per hour.

In actual practice the losses due to clearance, wire-drawing, incomplete expansion, cylinder condensation, etc., would have to be added to the amounts above given.

If in the last case (*C*) we add 10 lbs., making about 30 lbs. per h. p. per hour, we shall have an average practical result as obtained from automatic single cylinder engines of fair size.

The great loss due to cylinder condensation is largely dependent upon the difference of temperature between that of the steam at admission and that at exhaust. In cases *A*, *B* and *C*, this difference is respectively 42°, 81°, and 102°, and hence, with the same size cylinders in each case, it is quite sufficient to make the same allowance of not more than 10 lbs. additional for *B* and *C*, making for *B*, about 57 lbs. per h. p. per hour, and for *C*, 70 lbs. per h. p. per hour.

Now, in an engine operated in such a manner there would be, during expansion, a loss of heat due to conversion of the internal energy of the steam into work amounting to $\frac{16 (P_1 V_1 - P_2 V_2)}{772}$ $\frac{31104}{772} = 40.3$ thermal units per pound of steam, which would produce a condensation amounting to 3.3 per cent. The total thermal units (above 32° F.) per pound of steam at 105 lbs. (absolute) pressure is 1182.4 or $(1182.4 - 187) = 1000.4$ above the temperature of the feed water (212° Fahr.) Hence the available heat in the exhaust would be $1001.1 \times .687 = 968.35$.

Before entering the cylinder, however, the steam at 180 lbs. (absolute) contained (1195—181)—1014 thermal units per pound above the temperature (212° Fahr.) to the feed water. Hence the total loss due to conversion of heat into work is $1 - \frac{968.35}{1014} = .045 =$ 4½ per cent.

In addition to this loss in the cylinder of the engine we must consider a further loss at the boilers owing to the fact, that by raising the pressure we have increased the temperature of the steam 42°.

Now assuming that the increase of the temperature of the escaping gases amounts to 42° (and it certainly can be no greater) and allowing 24 lbs. of air per pound of coal, we have $42 \times 24 \times .238 = 240$ thermal units lost per pound of coal burned.

Now assuming that one pound of coal evaporates at 105 lbs. pressure (absolute) 8 pounds of water which is equal to $(1182.4 - 181) \times 8 = 8011$ thermal units, the loss at the boilers therefore may amount to $\frac{240}{8011}$ = about 3 per cent. Adding this to the previous loss of 4½ per cent. we obtain a total loss of 7.5 per cent. But this loss must be figured on a basis of 70 pounds of water per h. p. per hour and hence when computed at 30 pounds becomes $\frac{70}{7.5 \times 30}$ = 17.5 per cent.

Therefore we have practically obtained our work in the high pressure electric light engines at the rate of five and a quarter pounds per indicated h. p. per hr., the re-evaporation during exhaust, together with the unbalanced motion of the steam due to eddies, wire-drawing, etc., appearing again as steam or useful heat in the street mains.

This is clearly an extreme case, but for this reason it better serves as an illustration. The percentage of steam condensed to water through the conversion of heat into work during expansion would be greater in Cases 1 and 2, but in these cases it would hardly be necessary to consider any possible extra loss at the boiler.

Diagram D is the representation of an indicator card taken from an engine operating under conditions of excessive back pressure similar to case No. 3, diagram A. The back pressure in this instance was about 55 lbs. above atmosphere and the initial pressure about 130. The engine was an automatic cut-off type taken from the salesroom of a well-known engine builder, having been built for ordinary duty and not especially designed or altered for work of this unusual character. The engine was directly belted to a 750 light A. C. Westinghouse dynamo, which supplied current to about 600 incandescent lamps in the Lenox Lyceum, 59th street and Madison avenue.

The building was wired throughout on the Edison three-wire plan and the converters were arranged two in series with a middle wire to suit these conditions. The plant was supplied with electric meters and the various station instruments, and represented therefore, on a small scale, a central electric light station. The exhaust pipe of this engine was directly connected with our street mains, where an average steam pressure of about 55 lbs. was always maintained. The steam from the street mains was used in part for operating elevators in apartment houses and for running engines, and in part for heating. If we follow the steam in its course through the electric light engine, thence through the elevator, engines and pumps, and other engines along the line of the underground steam mains, and thence to the radiators where condensation takes place, it will be evident that an economy is attained similar to that in a compound condensing engine, the electric light engines playing the part of the high pressure cylinder, the other engines playing the part of the low pressure cylinder, and the radiators taking the place of the condenser.

This engine was operated under these conditions three or four evenings a week for about a year, affording a perfectly steady and satisfactory light for incandescent lamps. The running of the engine was not attended with any special difficulties and gave no more care and occasioned no more trouble than if exhausting into the atmosphere. On several occasions the exhaust of the engine was shut off from the street mains and turned into the atmosphere, the initial pressure being reduced at the same time to correspond. At other times the reverse of this change was effected and the exhaust turned from the atmosphere into the street mains without in either case producing a noteworthy fluctuation in the light from the incandescent lamps.

The gross revenue to be derived from the sale of steam for the heating of buildings may be estimated at from $2.50 to $5.00 per thousand cubic feet of space heated per season. The amount of heating to be obtained per mile of street mains will evidently vary very much according to locality, and in the dozen or more district steam companies, it is interesting to note what this variation is. In the smaller towns where systems of underground steam distribution exist, the space heated seems to vary from 1 million to 2 million cubic feet per mile of street main, and in the case of a larger city reaches 5 millions, and in the city of New York exceeds 15 millions.

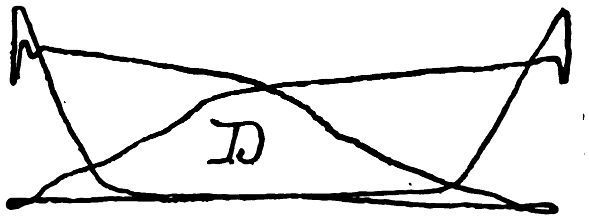


Diagram of Engine Working Under Excessive Back Pressure.

The cost of plant (which in these figures includes boiler house and boilers), varies from $20,000 to $30,000 per mile, and in one instance reaches $50,000.

In New York city the cost very much exceeds these figures, owing in part to the difficulties encountered and in part to the fact that the street mains were laid with a view to supplying steam for power. In the N. Y. plant, the pressure of steam in street mains is above 80 lbs. and furnishes a supply to over 500 engines and requires for this purpose in the summer time about 250 tons of coal daily, and, including heating, reaches 500 tons daily in the winter. The cost of plant is greater in cases where steam is furnished for power as well as for heating. The actual cost of a district steam plant, where the business is confined to heating alone, seems to vary from $10.00 to $20.00 per 1,000 cubic feet of space heated. Here again this cost includes boiler house and boilers.

In order to make it clear beyond dispute that the business of a district steam company can be added to that of an electric lighting company without prejudice to the latter, two points only need be established. First, the possibility of utilizing the exhaust of electric light engines without detriment to the light, and without introducing any serious complications or expense in the management of the station. Second, the certainty of an extra revenue, the net profits of which will equal or exceed the profits from the lighting plant for equal amounts of money invested. I have already touched upon both of these points and need, I think, only refer to the practical working of the combined system at the 58th street station of the New York Steam Company, where the back pressure of the engine was 55 lbs. (with no inconvenience and with no extra expense, save an almost indeterminate increased consumption of fuel) to prove that with a back pressure of only 15 lbs. a practical mechanical success is assured. Of course, to get the same power from the engines, it would be necessary, unless previously running with a light load, to increase the initial pressure 15 lbs., or to the same extent that the back pressure is increased. The effect of this, as I have shown, will be merely to pass a little more steam through the engine per h. p. which ordinarily would be a bad practice and a waste of fuel, but when distributed and sold for heating purposes has nearly the value of live steam taken direct from the boiler. There would be times of course when the demand for heating would be slight and when therefore it would be more economical to use a free exhaust, or, where there were several engines, to have only a portion of them deliver their exhaust into the street mains. The experiments of the New York Steam Co., previously cited, showed that the engines could easily be shifted from one exhaust pressure to the other without detriment to the light, and therefore be easily possible to secure at all times a maximum of economy which a combined system would permit.

So far as profits and dividends are concerned a very considerable saving would follow by the mere union of the two interests without even taking into account the value of the exhaust steam. Since, however, so much is dependent upon local conditions it is impossible to give figures which would apply to anything more than a hypothetical case. The amount of heat lost by radiation from the pipes of the New York Steam Co. showed the loss to be about 3 per cent. of the carrying capacity of the pipes. It may well be added here, as having a most important bearing on the profitableness of such an investment, some of the details of the cost of underground steam work. The sizes of pipe most common in practice are those having diameters of 4 in., 6 in., 8 in. and 10 inches, the carrying capacity of which with steam flowing with an initial head of 15 lbs. are respectively about 50 h. p., 150 h. p., 300 h. p. and 600 h. p. The cost of the underground construction, which includes valves and the special appliances, such as variators, service boxes, anchorages, insulation, etc., may be roughly estimated at $7.50 per foot for the 10 inch, $6.00 for the 8 inch, $4.50 for 6 inch and $3.50 for the 4 inch. In many instances where large buildings adjoin the lighting station, many of the appliances may be omitted and much of the expense spared which must usually be counted in the cost of long distance work.

The average price received for steam from the aggregate of consumers large and small is somewhat more than double the cost of producing the steam at the boiler house. This average price is one willingly paid by the consumer, owing to the saving in cost of labor and to the many conveniences, and advantages to be derived from having steam on tap like gas and water. Out of these gross earnings, which exceed 50 per cent. of the receipts, there must be subtracted the cost of maintaining the street system, leaving a balance applicable either for dividends, improvements or new constructions, or, as is often the case in new enterprises, this balance must be expended in reconstruction made necessary through defects arising from lack of experience at the start.

The entire annual gross receipts of a plant is, of course, limited by the carrying capacity of the pipes and may be estimated at about 40 per cent. of the cost of construction, and therefore net earnings of 25 per cent. will permit of 10 per cent. dividends. Since the cost of steam amounts to 50 per cent. of gross receipts, it is evident that if one-half of the steam sold for heating can be obtained from engine exhaust the saving effected in this way alone will amount to enough to pay a ten per cent. dividend.

In this paper I have attempted to show the complete, practical and commercial feasibility of combining a system of steam distribution from a central station with an electric light plant in a manner to utilize the exhaust.

I have given data that will assist in investigating the value of the plan in any locality where heating by steam could be introduced, but have purposely omitted to give any description or details of mechanical appliances and construction of underground steam work, as it seemed to me that the more important issue for discussion was the question: What has the distribution of steam from a central station to do with electric lighting?

ELECTRIC LIGHT AS APPLIED AND USED BY STEAM RAILROADS.[1]

BY W. H. MARKLAND.

AMONG the first to make use of the advantages afforded by electric lighting were the steam railroads, not as a means for lighting trains, but for lighting buildings, etc. In the year 1881 the Pennsylvania Railroad introduced its first electric lighting plant in a new shop in Altoona. That proved quite a success. It might also be mentioned that the same dynamo and lamps are in use today. In the year 1885 the Pennsylvania Railroad commenced lighting its depot shed in Altoona by arc light from its own dynamos, which proved a success as compared with the previous gas light, although it was crude to what the company now has.

The question then presented itself: Can freight yards be successfully lighted by electricity to reduce accidents, facilitate business and prevent breakage of cars and contents? The two latter items are quite a money consideration on any railroad. Some previous attempts had been made at lighting railroad yards by electricity, but without much success previous to the attempt in Altoona. I speak particularly of the Pennsylvania Railroad in Altoona, as I am very familiar with the lighting that has been done there, and also because what the Pennsylvania Railroad does is liable to be copied by other roads; and we sometimes get good ideas from other roads.

In Altoona, when drawing up the plan for lighting the yards, the question presented itself: How high and how near together shall the lights be placed? the problem of lighting the freight yard being more complicated than lighting a city; as in lighting a city lamps can generally be placed at street corners and quite low, the general public being not over-particular, so that under, or near the lamp, the light is quite brilliant, but in the space between lamps there is less brilliancy.

For lighting where engineers and trainmen have to work, it is not the brilliant light that is wanted, but the evenly distributed light. If a light be too brilliant, trainmen when near lamps will be partially blinded, as we might call it, for a short time; so in the event of their leaving a lighted space it would be difficult for them to distinguish objects or signals, and would lead to complaints.

In order to get an evenly distributed light, lamps at Altoona were placed on top of 65-foot poles, these being about eight feet in the ground, and set so as to illuminate switches and crossovers where the yards were narrow. Where yards were wide and long, lamps were placed about 600 feet apart, a row on one side of the yard and a row in a broad alley that was wisely left between tracks near the opposite side of the yard, the lights of the two rows being zig-zagged to prevent shadows and to better diffuse the light. This plan of lighting does not make a brilliant light at any point, it being possible, but difficult, to read fine print. A light more like moonlight was the result, and proved very good in practice. Even a clear globe was objectionable on account of the shadows of side arms. A lower-half ground globe was preferable, it having been proved by experience that it was better to lose a little light than to have shadows.

One noticeable result followed the introduction of this light. It enabled the car inspectors to examine cars much more thoroughly, and, as you all know, perfect car inspectors are very important. A decreased amount of pilferage also followed, as the watchmen were able to see persons at a great distance at night. The breakage of cars and their contents was but little, if any, greater at night than in day time. I cannot say how much money was saved by the introduction of the electric light from pilferage and breakage of cars and contents, yet I believe it was really more than the cost of maintaining the lights.

Undoubtedly the introduction of the electric light has prevented accidents to employés; of course I cannot say to what extent.

The electric lights are certainly a great help in shifting cars, as it enables the trainmen to see the tracks and position of switch points about as well at night as in the day time, on account of the light shining on the top of the rails, they being generally bright from passage over them, making a sort of reflector. Also in coupling and dropping cars it enables the brakeman to gauge the distance the cars are apart fully as well at night as in the day time, so cars can be coupled without any more jar or danger than by daylight. It also assists in dropping or switching cars very fast, as is often necessary during a time of increased traffic. It enables the switchmen in the towers to tell when a car is over a switch, so that they can quickly throw the switches with less danger of throwing the cars off the track or on the wrong track.

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[1] Read before the National Electric Light Association, Providence, R. I.

A few words about the erection of arc lamps and poles for freight yards. Poles must be very well set in the ground, and guyed so as not to sway from heavy rolling stock passing, or from wind. The poles, being high, receive the full benefit of the wind. A good, true chestnut pole for lamps, if possible to obtain, answers very well. They will cost when shaved, stepped and erected with hood about $35. The price will be governed largely by the cost of timber. Short poles must also be well put up so that there may be no breaks.

Railroad people are very exacting; it does not do to have any stops or shut-downs. The lamps must be kept in good order. Maintaining arc lamps near railroads is quite different from maintaining lamps in most stores. If there is a poorly insulated part in the lamp, the soot will soon find a path for the current across the poor insulation, and out goes your lamp. Your cut-out contacts will corrode very fast. When it comes to your rods, expect to have a lot of dirty ones. In a railroad yard there are things to contend with not common with most lighting, and that is smoke and steam. I have seen poles covered from one end to other with a flim of soot from engines. This, in getting on the hanger boards is sure to make escapes unless the insulation be very good. The insulation should also be good to enable the inspector to work at a lamp in case of its failing to burn when the current is on.

Get a good reliable direct current double carbon arc lamp that is well insulated. A lamp that is heavy, bulky, or has liquids is not well adapted for the purpose, on account of the difficulty of carrying it up the pole. Do not rely on the hooks of lamps for connection between the lamp and the hanger board, or they will corrode and cause trouble. It is better to always put a piece of flexible wire from the hanger board to the lamp to carry the current. Always use a good insulated wire and good insulators when running up poles or side arms. It is better to splice on a piece of the very best insulated wire. Experience has proved that the wooden part of hanger boards is better for having some waterproof insulation between it and the side irons to prevent leaks.

I do not favor double-pole switches on hanger boards in freight yards, as they require extra contacts, the brass work of which soon corrodes so as not to make good connections, and leads to trouble.

The dynamo should be self-regulating and easily kept in order. As there may be 100 lamps, taking, say, two dynamos for all lighting at one point, it is better to put a little more money into dynamos than to pay high wages to the dynamo tender.

Keep as far away from telegraph and telephone lines as possible. If any damage is done to either of the above, the railroad generally gets the worst of the suit.

If you are going to hire the lights from a central station, see that they give you good work, and make a contract with a rebate and fine for the time lights are out.

If you once properly put electric lights in a freight yard, you will never get them out again; the trainmen will not stand it, as they would be in the dark in more senses than one, if the lights were taken away. But if the lights are not properly put in, say, on low poles, under 40 feet above ground, or not properly spaced, the chances are there will be complaints on account of too much light at some one point and too much darkness at some other point. Great care should be taken to place lamps so they will not interfere with signals. I have seen cases where electric lights were so placed that a signal could not be properly distinguished on account of the electric light shining on the lenses and blending the colors. A case like this can generally be avoided by placing some arrangement so that the electric light will not shine on the signal.

The electric light is rather a help to distinguish the position of the semaphore arm, although trainmen at night look for the color of the lens rather than the position of the arm.

The electric light is something of a help in distinguishing the switch signals, on account of the light shining on the lenses. These being low, the light will rarely show through them.

If it comes to a question of moving an electric light or a signal, you will find that the electric light will have to go every time, as railroads will not allow any interference with signals.

If you go too high, you will not get the full benefit of the light, as has been proved where the tower system of lighting is in use.

In laying out freight yards, a broad alley, say 12 feet between tracks, should be allowed for placing the lamp poles, where the yards are over 300 feet wide.

As to the other uses for electric lights for railroads, I do not know. I do not know that there is much out of the regular run. The light is used quite extensively for lighting depot sheds, where it is more economical than gas and decidedly better. This class of installation requires the very best of work and insulation, as the smoke and steam nuisance enters in here. Even though depot sheds are dry inside, porcelain knobs should not be used, glass with a double petticoat being the only kind now on the market that answers the requirements well, on account of the soot settling on the insulators.

It does not do to have a depot in darkness; for that reason a depot shed should be wired with two complete circuits, having every alternate lamp connected to one circuit and the remainder to the other. Then, in the event of a break in the wire, only one-half the lights are out.

Experience has proved that the arc light is much superior to the incandescent for depot shed lighting. With incandescent lights the necessary volume of light is costly to maintain, and also the globes of incandescent lamps soon become dirty from steam and smoke, which interferes with the light, or, if cleaned off, necessitates considerable labor.

For freight transfer stations the arc light is very satisfactory. It enables the men to quickly distinguish marks on merchandise and also enables the foremen to see what the men are doing, preventing loafing. One 2,000 nominal candle power arc lamp to about 1,500 square feet of floor space will generally light a transfer station where lamps can be zig-zagged. Where transfer stations are narrow, more light per square foot should be allowed. On a platform about 10 feet wide, as they generally are, one light every 60 feet gives good illumination.

I doubt if the arc light can compete with gas for this purpose as far as cost is concerned, taking transfer stations as they are, generally lighted by gas, and as they should be, lighted by arc lights. Yet I believe, taking the amount saved in labor and from pilferage, that the electric lights more than pay for themselves.

Another point comes in here. We all know that on a wet, dark day we do not feel inclined to work as we do on a bright, sunny day. The same is the case at night; if you give men good light it brightens their spirits up and they will work much more cheerfully; and getting men cheerful means more work done.

For offices and shops the electric light is used considerably, much the same as for other places of like nature.

I hear that an electric headlight has lately been brought out which, it is claimed, will illuminate a track for a mile or more. I am of the opinion that the light will not come into general use. In the first place, a light for this purpose should not be too strong, or it will blind an engineer coming in the opposite direction, this being a serious objection. Most of the roads east of the Ohio are not very straight, and the chances are that while on curves the neighboring cornfield will receive more light than the track ahead, as no one has invented a light that will show around the corner.

If any inventor wishes to get up an electric locomotive headlight, let him confine himself to one of low candle power—the present ones are about 20 c. p. I do not think one of over 100 c. p. will be in demand until railroads are illuminated from one end to the other by electric light, which will be the case in the future, and then the headlight will not be required.

These points are necessary for an electric headlight: First, and all important, reliability; second, simplicity. Economy you can leave out. If you can get 50 per cent. of what can be attained in a station, it will do. One thing must be borne in mind—engineers are not electricians. Thus a dynamo and lamp must be as simple as the air-brake, and no more liable to get out of order.

The experiment has been tried of lighting cars by electricity. While it has proved a success in some cases, as far as convenience is concerned, financially it has not proved a success. Electric lighting of trains is a luxury to-day, and will continue to be until some more economical plan is invented. The advance that is being made with the use of gas as an illuminant for cars is leaving electricity behind. From the best information I can get, it costs 50 cents per hour to light a car by electricity from storage batteries, against 5 cents per hour from carbureted air.

The electric light is used to some extent by different railroads for lighting wrecks or any construction work that requires night work. For this purpose the Pennsylvania railroad and the Cumberland Valley road have a car fitted up with boiler, dynamo, engine, water tanks and coal bunker, and all the tools necessary for a central station. With a car of this description, quick work in getting lamps in place is all important. In one case after the Johnstown flood, I, with the help of four men and the engineer, put up six arc lamps, put up the poles for the lamps, which were designed for the purpose and carried on the car, ran the wire, coupled up the lamps, and had the lamps going in 35 minutes from the time we, with the car, lamps, poles and wire, arrived on the ground. The lights were distributed some distance, one being about one-third of a mile away. I doubt if construction work was ever done quicker.

I will not go into a description of this car, as it was very ably explained by Mr. W. F. Taylor, of Altoona, at the convention of railroad telegraph superintendents at Niagara Falls, June 19, 1890.

To give an idea of what the Pennsylvania Railroad Company thinks of the electric light, I might say that its new Juniata shops at Altoona, having about 100,000 square feet of floor space, are lighted entirely by the electric light; there is not a pipe for illuminating gas in any of the buildings. All the traveling cranes are run by electricity.

The Pennsylvania Railroad Company believes that good electric work pays. I doubt if any station, central or isolated, has more reliable or better designed appliances, or more artistic work than can be found at the Juniata shops of that company.

ELECTRIC LIGHT WIRING INSTALLATIONS FROM A MECHANICAL STANDPOINT.[1]

BY AUGUSTUS NOLL.

THE question is frequently asked by architects and owners of buildings, "Can electric lights be installed with safety from fire, and will the installation give results that are satisfactory, and permanent?"

The improvements made recently, in materials and methods, admit of answering in the affirmative.

Nearly all the troubles in electric lighting plants have been caused by defective wiring, and on that part of the lighting system, more than on any other, depends the success of future service.

It may not be amiss to compare the early date of the art of electric light wiring with the present, and the probable future advancement in the methods of installation.

In the early days of electric lighting, a wire, covered with cotton, and saturated with paraffine, was used; this in a short time was replaced by a wire covered with cotton and white lead, known as "Underwriters' Wire;" the insulation was supposed to be fire-proof, and on that account, decreased the chances of fire; while the insulation was non-inflammable, it also readily absorbed moisture, which caused excessive leakage and some incipient fire; a few carefully conducted tests and experiments, proved that "protection against moisture was prevention of fire," and henceforth a moisture-proof wire was demanded, and the manufacturers in that line now offer us such high grade insulations as "Grimshaw White Core," "Okonite," and others.

Improvements in the method of installing the wires were also made; formerly buildings in the course of erection were equipped with the fire-proof insulated wire encased in wood mouldings, or inserted in zinc or lead tubes, but with the appearance of the moisture-proof insulated wire, the former insulation was discarded for the latter, and instead of inserting the wire in zinc and lead tubes, it was fastened directly to the side walls and ceilings, and covered by plaster. The cut-outs and switches are now mounted on porcelain and slate, instead of wood as formerly. More attention was given to the equalization of electrical pressure on conductors.

While these changes helped to improve the work, it was still a matter of chance that wires placed in a new building and imbedded in plaster gave satisfactory results; conditions that could not be controlled, increased the difficulties. A cut from the plasterer's trowel or a blow from a hammer on the insulation, destroyed its utility; and though the wires may be tested, the fault in some cases, would not appear till the building was completed, when, to remedy the defect, it was necessary to cut the plaster to obtain access to the wires, or discard the faulty circuits and rewire on the surface of the plaster, in either case disfiguring the walls and causing extreme annoyance; again, should changes be contemplated in the wiring, such as an increase of lights on different outlets, or a change to a lighting system where lamps of a lower voltage are used, we are once more confronted by work that is totally inaccessible, and to make the changes required, are forced to have recourse to the same expedients as stated before, and with the same results.

Although wiring installations gave better results than formerly, there was yet a large field for improvement; access to the conductors became absolutely necessary for controlling the system, making changes and rectifying defects which may occur after the work is finished and the building completed, and to do so without cutting or defacing the walls, or interfering with the other portion of the lighting system.

It is evident that as long as the conductors are inaccessible, just so long will the results be uncertain, and as it is our aim to eliminate the objectionable features and secure a wiring system that possesses accessibility and freedom from fire and leakage, the question is: "What is necessary?" To which I reply: A high grade moisture-proof insulated wire together with a system of "raceways" or conduits, and a complete line of "fishing" or junction boxes.

The conduits should be of ample size, with smooth inner surface, so that wires can be easily inserted or withdrawn; they should be constructed of materials that will not stain nor exude through plaster or paint, and should be non-combustible and moisture-proof; the action of lime or cement, or extreme variations of temperature, should have no effect.

The "fishing" or junction boxes should be equipped with shoulders or sockets for the entrance of the tubes, thereby making them a part of the conduit system, and preserving the continuity which is so essential in a system of this kind, and also enabling us to make the joints moisture-proof.

All cut-outs when single or in groups, should be located in the junction boxes.

The conduits should be installed in a workmanlike manner; they should not be run or looped from one outlet to another, but branches should lead to each outlet from the main conduit carrying the wire for that circuit, and at right angles with same; at the intersection of the branch and main conduits, a "fishing" box should be placed; the main conduits may be located in the cornice near the ceiling, or behind the base board at the floor with the cover of the junction box flush with the surface, thus keeping them out of sight and at the same time easy of access. The location of the conduits should be uniform on the different floors throughout the building.

An extra covering of metal should be placed on the conduits at the outlets, to keep them securely fastened to the wall, protect the ends, and take off the strain when inserting or withdrawing wires.

With a proper conduit and a complete system of junction boxes, it becomes unnecessary to insert a single wire (with the exception of the main feeders) until after the installation of conduits is complete, and the building finished; the insertion of strings or drawing lines is equally unnecessary, for, should the string or wire break near the middle of its length, that circuit would be as inaccessible as though it were imbedded directly in the plaster.

The main wires can be inserted in the conduits at the time of installing same, and placed in recesses in the walls, the cover of the recess to be detachable.

In hotels, apartment houses, office buildings, and other structures used for similar purposes, the largest part of the wires and conduits, together with the cut-outs and junction boxes, can be located in the halls, so that in case of alterations or additions being required, the occupants of the rooms will not be annoyed.

Considering the advantages a wiring system of this kind possesses over previous methods, a comparison in cost will be favorable to the conduit system.

The indefinite manner in which electric light wires are sometimes installed, has often placed the owner of a building, who contemplates changes, at the mercy of the company or contractors, under whose supervision the work was installed; they in turn delegate the foreman who had charge of the work in that particular building to attend to the changes required, and he usually tries to obtain the services of some of the wiremen who worked on the installation, because "they know where the wires lie."

It is apparent that the employment of a complete conduit system obviates these troubles, and also that instead of equipping a building with a wiring system suitable only for a special company's system of lighting, it can be fitted with conduits for electric lighting, regardless of system, and in fact, similar to piping the building for gas; and should a change in system be desired in the future where lamps of a lower voltage are used, the change can be made without cutting or defacing the walls, and at a nominal cost, whereas, should this change be required in a building where the wires are imbedded in plaster, it would practically necessitate the rewiring of the entire plant, and at a cost at least equal to that of the original work.

While a conduit of good insulation is necessary, it should not be regarded as extra insulation or protection, to an extent where the insulation directly on the wire is decreased, it should only be treated as a medium to accessibility.

"Prevention is better than cure," and for that reason only one wire should be placed in a conduit. Although the fusible metal cut-out will usually break the circuit in case of a "cross," still, it is safer to guard against any formation of this nature, by placing each wire in a separate tube, than to invite it by insufficiently insulated wire, or inserting wires of different polarity in the same tube.

Only the best is good enough, and will in the end be the cheapest for all branches of electric lighting.

The co-operation of architects is not only desirable, but necessary for the future advancement of electric light installation work, and to their credit be it said, that they are ever ready to extend their help; already have their suggestions been of value to us, and should the necessity of securing separate recesses be explained, they will, without doubt, make provision for the work similar to that made for gas, steam, and water pipes.

MUTUAL INSURANCE OF ACCOUNTS.[1]

BY FREDERIC A. C. PERRINE, D. SC.

THE recent financial crisis has been happily passed in a manner never before attempted or imagined in the history of business and banking. At any moment one of our sensation-loving newspapers, willing to handle fire, might have precipitated the whole country into financial ruin, by persistently teaching fear and liquidation, but, taking as they did, an optimistic view, they did not check the new force in banking, mutual support.

It may be objected to the use of the term new force, that "mutual support" is the very underlying principle of banking as it has always been practiced, but its application in approaching times of panic is almost new enough to be called a discovery. Mutual confidence in ordinary times is but the belief that any one, when individually called upon, can at any time meet his current obligations, but the principle applied by the bankers of Europe and by our New York clearing house, is essentially the belief in the solvency of the country, or the world as a whole. Two forces tended to bring about this happy result, one acting here and the other abroad.

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[1] Prepared for the National Electric Light Association, Providence, R. I., Feb., 1891.

[1] Read before the National Electric Light Association, Providence, R. I.

In Europe the Barings were not the only bankers heavily involved in South American securities. They, indeed, were the heaviest holders of Argentines, and had taken the initiative in attempting to float them, but, failing in this, the load became too heavy for their individual shoulders, and their fellows were ready enough to give them aid which would also protect the smaller holders, in which number is included all except one or two of the great bankers.

Six months or more ago, the possibility of a crisis had been foreseen by our bankers, some of whom are intimately connected with South American affairs. By them it was known where lay the greatest financial dangers, and that these dangers concerned us only indirectly, through our speculative markets, rather than through the ordinary channels of business. When the crash came, and the worst was averted by the ready loan of gold abroad, our clearing house, feeling that a lack of confidence was the one dangerous element, ventured upon the experiment of the issue of a new form of currency, namely, the clearing house certificates.

Now that the air is clearing and we look about us, we find among the most sensitive lines of business the industry of electric lighting. Very few of the companies are thoroughly on their feet as regards ready cash, being but young, and spending their earnings in necessary extensions; almost none are individual concerns, the majority being stock companies, and, as a consequence, feeling immediately the the waves of the market. Many, noticeably the electric railroads, were in the midst of initiative constructions, and just about to float their bonds; but we can proudly say that nearly all were, and are, looked upon as successful business ventures, safe enough while confidence lasts.

These considerations have led to the thought that, without looking to outside bankers or business men, the electrical business should form an association of confidence, capable of rendering them independent of the market, if not even a stay to it, in future crises. It is thus that we see an association of confidence used by the bankers of the New York clearing house, and following immediately upon their action, the timely speech of Edward Atkinson before the Boot and Shoe Club of Boston, proposing its continuation as a general principle, and its extension to the needs of every day life, in a money issued by the clearing houses, based upon the stability of the business men of the country, and backed by a reserve in coin, only to be called upon in time of greatest need. In the course of his speech, to show how little the risk, he cites the fact that, in his extended experience of business, the losses through bad debts have not amounted to one-half of one per cent. of its value; this low average, I believe, has hitherto been much too high, applied to the electric light and railroad industries.

If, in view of these facts, the electrical companies would form a mutual association for the purpose of insuring their accounts, the effect would be that of increased capital in the business, relieving their creditors of much of their anxiety, and rendering stable the stock and bonds of the associated concerns. The risk of an account is not greater than that of anything else for which insurance is granted; a man's life, or loss by fire, for instance, while resembling rather the latter than the former. It is a calamity which no man expects, and one to be guarded against by the most strenuous means. The loss, stated above, of one-half of one per cent. as incident to general business, includes not only the losses due to bad management and dishonesty, but also the failures occasioned by these very times of weak faith, against which this plan is directed. These being eliminated, the business losses of an electrical company could be reduced to a minimum, and dividing these losses among the many, would make them a burden to none, while conferring upon all the benefit of a practically increased capital of a credit money.

In detail, the plan should be to form, among the electrical companies, a mutual assurance society, each company pledging individually its entire capital for the assurance of all accounts outstanding against any member, for which benefit a charge should be made covering expenses through administration or losses, proportionate to either the capital involved, or services rendered.

The assurance of the account could be effected in one of three methods, either of which would require elaboration and further study. First: the association might issue a series of promissory notes payable on demand, by means of which accounts could be settled, and which could be sold to various companies whose notes could be taken in exchange; this would involve a possibly expensive administration, and considerable ready capital, besides being probably liable to a tax imposed by the government on a circulating medium.

Secondly: the association might, without inquiry, insure all accounts, and be called upon only to adjust in case of failure. This would allow the greatest opportunity for dishonesty, and make it extremely difficult for the association to ascertain at any time its liabilities, except by a complicated system of bookkeeping involving the rigid inspection of the books of the insuring companies.

The third, which appeals to one as being the simplest plan, is that the association appear as an indorser on notes, or an insurer for accounts, when called upon to do so by any member, thus taking the position of a trust company. In the case of any one of the insured companies becoming involved, action should be taken by the association, depending upon the contingent circumstances; in the case of a temporary embarassment, the notes should be paid to the holders on maturity, and the company carried by the association till such a time as it could discharge its obligations. Were mismanagement apparent, the association should have the power to enforce a more economical or honest administration; or if, finally, the business were found to be necessarily unprofitable, the creditors should be paid in full and the company be closed out for the benefit of the association. No surrender of administration is contemplated here before such a time as the account could be shown to be in actual danger.

The insurance of an account may seem on first consideration to be rather a startling innovation in business methods, but I believe it to be based upon a firmer and more rational foundation than the insurance against loss either by fire or accident. Both of the latter are based upon a system of probabilities in which the insured expects his policy value to be greater than his premiums, and the success of the company proves it not to be true in the long run; the mutual insurance of an account, on the other hand, depends on the belief that all the accounts will be, in the main, stable, and that internal faith will induce a greater faith from the outside.

The objection that it is a scheme of the weak companies to be supported by the strong, and that they who would offer the greatest stability would not enter it, is answered in two ways: in the first place, as has already been said, the companies involved in the electrical businesses are in almost no cases individual concerns, and, as stock companies, are subject to extraordinary effects of bad and expensive management and fluctuations of the market; secondly, they are none of them so solid and stable as to be entirely removed from fear of depression, or need of funds for extension. Again, the very principle involved is that, as a whole, there are no weak companies in the business, if only times of depression be avoided.

To the objection that an unlimited liability company would be avoided by all, the same answers would be offered, with the addition of pointing to the Guarantee and Accident Lloyds, of New York, and Lloyds of England, as stable examples of the application of the principle to ordinary insurance.

The initial subscription of the small amount of a few thousand dollars by each insurer, would be the capital needed, its only use being to meet imperative accounts, while the administration would be of the simplest, requiring a minimum staff of efficient men whose services would be called upon to adjust irregularities and issue insurance.

This scheme is offered to the electrical fraternity, believing that by it the best interests of both the electric light and railway companies and the supply houses will be preserved, and that through it the electrical interests will not be a menace, but become a source of stability to the finances of the country.

REPORT OF COMMITTEE ON RELATIONS BETWEEN MANUFACTURING AND CENTRAL STATION COMPANIES.[1]

BY MARSDEN J. PERRY, CHAIRMAN.

THE functions of this Committee are almost defined by its title. The idea of, and the necessity for, this Committee, is to have a recognized counsel for mutual conference and conciliation in case either a Manufacturing or a Central Station Company should feel aggrieved by the business methods of those with whom they may have dealings, or be called upon to contend in business competition. In cases of this kind, the Committee can take no action unless requested so to do by one of the aggrieved parties. No such appeal has been made to the Committee.

This Committee is also intended to represent the general interests of Central Station Companies in case of unwarrantable competition in cutting prices for public lighting contracts, or to secure franchise rights in a town where a company is already in active operation and ready to perform all forms of service required, at reasonable rates. Your Committee is glad to state, that no case of this kind has been brought to its notice since the Twelfth Convention. It has, therefore, not been called upon to use the influence of the Association in that direction.

It is thought advisable to continue the Committee as one of the standing Committees of the Association. The time may come again, as it has certainly existed in the past, when it will be necessary for this Committee to exercise functions such as those indicated, or conduct negotiations of a different character under instructions from the Association.

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[1] Presented at the National Electric Light Convention, Providence, R. I.

THE FERRANTI SYSTEM.[1]

BY CARYL D. HASKINS.

I keenly appreciate the compliment which your committee has paid me, in naming me to appear before you today to read a paper.

I fully realize that much is expected of me, and I believe I even more fully realize my inability to handle the subject with the completeness which I could wish.

My connection with Mr. Ferranti was not of long duration, and it is now some time since I severed my connection with him, so that my information, whilst pretty complete as far as it goes, is not as thoroughly up to date as it should be.

The Deptford station was far from finished when I left London, and 10,000 volts generated direct from the dynamo was still a matter for surmise and conjecture.

Under these circumstances the best thing I can do, I believe, will be to take up each feature of the system separately, and describe it to you in its various forms and applications as thoroughly as I can. Starting with this plan in view, I have arranged my paper under the following heads:

Methods of Distribution.
Ferranti Dynamos.
Ferranti Transformers, Fuses, etc.
The Ferranti Meter.

Starting then with Mr. Ferranti's methods of distribution, I will deal first with the old and somewhat famous Grosvenor Gallery station, from which current, at a pressure of 2,500 volts, was distributed throughout the most wealthy portion of London's West End, by means of overhead wires.

At the Grosvenor station there were two dynamos, each of 625 horse power nominal. These machines I will describe later on.

From these generators the circuit was carried to five double-pole, double-throw switches, each having a break of two feet and breaking both sides of the line at once.

Each of these switches represented a circuit, there being five circuits in all run from the Grosvenor station. It will readily be seen, therefore, that the switchboard of this station, which distributed light to no less than 35,000 lamps, was an exceedingly simple affair; yet, with their five switches, any desired combination of machines and circuits could be made.

It has quite frequently been stated, I believe, that these two machines at the Grosvenor were run in multiple. This is in no sense true, though, since the removal of these dynamos to Deptford station, they are to be connected in this manner, I understand.

From the five main switches the current was carried through Ferranti plug fuses of rather peculiar construction, having a break of two feet. These fuses I shall describe later. From the fuses the circuits were carried on ordinary wiring to an overhead distributing pole. From this centre the wires branched in five directions, being carried over the house-tops, and not through the streets as is our custom in America.

Stranded steel cables $\frac{7}{16}$ B. W. G. are stretched from pole to pole, and from these cables the mains are supported at frequent intervals by means of leather thongs or slings, thus saving undue chafing and straining of the conductors. This method of supporting the mains presents many marked advantages; the wear of insulation is reduced to a minimum, and the liability to a ground is very much diminished. The leather slings stand the wear and weather exceedingly well, and renewals are much less frequent than would be expected, especially if one take one's foot wear as a basis for calculation.

All streets are crossed at right angles, and no difficulty is experienced with the ubiquitous telephone man.

Contrary to the custom in this country, the primary wires are generally run into the house to be lighted, where they are connected to the transformer, a Ferranti fuse being placed in the circuit.

The secondary circuits are of 50 or 100 volts pressure, as may be required, and the house wiring is quite of the usual style, having a principal secondary fuse at the transformer, and a Ferranti recording meter in series with the lamps.

The Grosvenor Gallery, as a generating station, is now a thing of the past. It has been reconstructed, and is now one of the four transforming centres of the Deptford system, which draw their energy at the phenomenal pressure of 10,000 volts from the machines in the great station on the Thames.

This heavy pressure is reduced at these central points by means of large transformers, and is distributed over the London housetops at an E. M. F. of 2,500 volts in the manner I have already described, the only difference here being that these overhead mains are on a secondary instead of a primary circuit, and the house circuits become tertiary instead of secondary.

The portion of the Ferranti system of distribution which has given rise to the most interest, and which has been most talked of, is the present primary circuit, extending from Deptford to the four central distributing stations in London.

Many curious and wonderful letters regarding this have appeared in our journals at various times, and have given rise to much confusion and many wild conjectures, whilst the real facts of the matter are, I believe, but little understood.

The shape and principle of Mr. Ferranti's concentric main is familiar to all, but a few words descriptive of it may not be out of place here.

Over a copper tube, about 1½ inches in diameter, insulation is wound in the form of a stout manilla paper, thoroughly saturated with a special insulating compound. This insulation is wound on to a thickness of one-half inch by a machine specially designed for the purpose by Mr. Ferranti; over this insulation a second copper tube is placed, of the same sectional area as the inner one, and this is drawn down till tight.

The cable is made in lengths of 20 feet, and stands static tests of immense pressure. Special plug and expansion joints are provided for connecting the lengths, which are also thoroughly reliable.

The original intention was to lay these mains with the outer tube directly to earth throughout its entire length, thus rendering the system absolutely safe, since only one side of the circuit could be touched by the hand, and there would be no difference of potential between this and the ground.

Alternating circuits, and grounded telephone lines do not agree, however, and the law demanded that the Ferranti mains be laid duly insulated from earth; this is therefore done, but one terminal of the machine is still connected to ground, and comparative safety is the result, since it will readily be seen that to short circuit through the body, it would still be necessary to touch the inner tube of the conductor. This would necessitate cutting through the outer tube and insulation, which would mean a short circuit from tube to tube, through the cutting instrument, a dead short-circuit on the machine, certainly, but perfectly safe for the meddler.

At the collector boxes of the machines an accident is impossible, since the collectors are enclosed within an iron box, the lid of which is magnetically locked by the exciting current—nor can the machine generate when the box is open, since the exciting circuit is not complete till the box is closed.

Unfortunately time was an object in the starting of the Deptford station, and much contract-made cable was laid; the greater part of this was the lead-covered cable so frequently mentioned; this was not of the concentric pattern, but an ordinary stranded cable—I understand that it was guaranteed to stand considerably above 10,000 volts, but after being laid it was found not to stand 10,000 at all, and to give but poor satisfaction even at 5,000.

This unfortunate trouble has given rise to much talk, and has been scarcely well understood by the general public.

Several other kinds of cable were tried, but gave equally unsatisfactory results, and all mains have, doubtless, by this time been replaced by the Ferranti concentric cable, which stands the pressure perfectly, and gives most satisfactory results.

Of the various expedients to which Mr. Ferranti had recourse during this trouble with the cables, I am not prepared to speak, first, because I am not fully informed regarding them, and secondly, because they form no portion of the Ferranti system of distribution. They were simply makeshifts, necessitated by an unfortunate happening, and by lack of time, and they have probably given rise to more discussion, both in and out of the papers, than has the system itself.

I will now pass on to a description of some typical Ferranti dynamos. First among these, a few words are due to the original form of Ferranti alternator, which, while it is no longer manufactured, still, without doubt, was a machine of marked efficiency and great originality.

The characteristics of this earliest dynamo are, I think, about as follows. The figures are not based upon my personal experience, for the machine was out of date long before my time, but upon various fragmentary notes from my pocketbook, and a generous quotation from Thompson's "Dynamo Electric Machinery."

As in the Siemens machine of similar type, the fields formed, as they do now, "two upright circular crowns of electro-magnets with opposing poles." There were 16 magnets on each side; 32 in all.

The peculiarity of the machine lay in the armature, which consisted of a series of zigzag loops, eight in number, wound or folded one layer upon another, and separated by alternate ribbons of strip insulation of similar width. The winding was in three multiple circuits, each strip making 10 turns around the zigzag coil 30 layers of winding in all.

Each of these three coils is connected at one end with a solid star-shaped brass boss, which, bolted together from either side through the loops of the zigzag coil, form a solid centre for the disc armature, and at the same time connect directly with one of the collector rings; the three coils all again uniting in an inner star-shaped piece of brass, which in its turn communicate with the second collector.

This disc armature was 30 inches in diameter and one-half-inch thick. Its extreme thinness permitted the magnet poles to be brought very close together, enough space only being allowed to insure safe clearance. The natural result of this was a very efficient field.

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[1] Read before the National Electric Light Association, Providence.

The dynamo was calculated for a speed of 1,400 revolutions per minute, and maintained a pressure of 100 volts. The armature weighed less than 100 pounds, and the entire machine rather less than 1½ tons.

Most of these old machines are still in use, principally upon British war ships, and are doing good service.

An excellent type of all the more modern Ferranti machines is the 150 horse-power dynamo, which has been manufactured in considerable numbers, and is the alternator generally in use in most of the smaller stations using the Ferranti system.

In this machine the number of parts has been reduced to a minimum, and the efficiency is very high; it will fully illuminate 8,000 ten candle-power lamps, requiring an average energy of over 35 watts each.

The fields are arranged as in the old machines, and have 20 magnets on each side. The distance between the opposing faces of the fields is rather less than three-quarters of an inch, and within this narrow space the coils of the armature rotate at a speed of 400 revolutions per minute. The armature being four feet in diameter, this makes a peripheral speed of 4,800 feet per minute. The diameter of the armature shaft is 4½ inches, which at first sight seems rather large, since there is no great weight to carry, but the size is needed, since the armature is overhung.

This armature is without iron, and consists of a central boss of gun-metal, into which are fixed 10 carrying-arms of brass. These are insulated from, and held into, the core by a special mixture of sulphur, which is poured in in a liquid state and sets harder than metal itself.

This sulphur insulator is one of Ferranti's specialties and prides, and much of the success of his machine is, I believe, due to it. I never, during my stay with him, met with a ground on an armature shaft.

Each of the ten carrying-arms which I have just mentioned, holds two coils or bobbins of copper tape, tightly wound by machinery on a centre made up of alternate strips of asbestos and brass. Terminating at one extremity is a gun-metal butt-piece, the entire coil being fastened to the carrying-arm by a single bolt passing through this butt-piece, and drawing the bobbin into place.

The winding of the bobbins themselves is of alternate layers of corrugated copper and fibre ribbon, the object of the corrugation being to prevent lateral slipping—a very necessary precaution.

The thickness of the bobbins, which form the only portion of the armature projecting between the fields, is one-half inch, which leaves a margin of less than one-eighth inch clearance on each side.

The coils are connected in two parallel circuits, which are conducted away through the carrying-arms and the rods within the central boss itself, to the collector rings, where the current is taken off by Ferranti collectors—two half circular pieces of metal like the two halves of a severed ring, which almost surround the collector rings, and are held together by bronze springs, making an extremely good and constant contact, and not running at all hot.

The machine can be very quickly repaired; the two fields are divided at the centre, and slide back very readily, right and left, on extension bases, by the the aid of a simple levering device. The armature is then exposed, hanging in its usual position, and it is but the work of a moment to take out and replace a burnt coil with a new one.

A few details regarding the two 625 horse-power machines formerly used at the Grosvenor station, and now being installed with changed winding, to take the light day load at Deptford, may be of interest here, before I pass on to a description of the giant machines of the Deptford station. These two dynamos are in construction almost exactly like the 150 horse-power type which I have already described. The machines were originally designed to give current for 10,000 ten candle-power lamps each, but have frequently carried as high as 19,000 lamps without apparent effort. The weight of these dynamos is 35 tons. The height from floor is 9 feet 6 inches; the floor space required, 9 feet by 11 feet; armature diameter, 8 feet 6 inches; potential maintained, 2,500 volts; speed, 280 revolutions per minute.

There are 40 coils, or bobbins, in the armature, and 40 field magnets on each side; 80 in all. The pulley is grooved for rope driving, Mr. Ferranti being fully convinced that this is infinitely better than the best belting.

It has probably been already remarked that I have made mention of no regulating device for the dynamos. Mr. Ferranti makes no provision for automatic governing, nor is it needed. It must be remembered that there is absolutely no iron in the armature, and that the machine is, therefore, self-regulating to a very large degree.

There is no compounding of the field, the field circuit being entirely simple and separate. At the Grosvenor, the exciters used were Siemens machines, giving 108 amperes at 100 volts. At Deptford, Kapp machines coupled direct to Allen engines are used. These Kapp machines have rheostats in their field circuits, not for use in regulation, but in starting up and in case of emergency. It will be noticed that the two machines I have just described have not armatures arranged with the zigzag winding, adopted in the original Farranti machine. This zigzag winding was abandoned for several reasons. It was impracticable for large armatures and a winding made up of separate bobbins, or coils, which could readily be removed and replaced, was found to be exceedingly desirable. To meet these requirements, therefore, the method of winding was changed to an arrangement similar to what is generally spoken of in text-books as the "Siemens alternating armature."

It now remains to me, before passing on to the less important apparatus of the Ferranti system, to give a brief description of the two sizes of dynamo which are installed, and being installed at the Deptford station.

So much has been said and written about these during the past year or more, that I almost hesitate to mention them at all, so sure do I feel that almost every one here is familiar with their general character and dimensions.

The Deptford machines will be of two sizes, the portion of the station to be put into immediate use, calling for three dynamos, two of 1,500 horse-power each, and one of no less than 10,000. Of these the two first are now installed and running, whilst the 10,000 horse-power machine is still in course of construction, it being far too enormous a piece of machinery to admit of hurrying.

Each of the 1,500 horse-power machines is driven by means of 40 five inch ropes from a compound vertical condensing engine of marine type, having a grooved drum or driving pulley 24 inches in diameter.

The carrying-arms of the armature, which support the winding, are fixed directly into one end of what may be called at once the pulley and the armature boss, by means of sulphur insulation. Into these carrying arms are fixed the 48 bobbins which constitute the winding. The total diameter of the armature is 12 feet 6 inches. The fields are arranged as in the smaller machines and have 48 magnets on each side, 96 in all. The copper strip composing the winding of the armature is three-quarters of an inch in width, and 1½ millimetres in thickness.

There is only one inch of space between the opposite magnet poles, and within this the armature rotates, having one-half inch clearance on each side.

Small fan-shaped ears are cast onto the carrying-arms of these, and the other machines which I have described, which, when the machines are in motion, force a constant current of air between the armature and the field, keeping up a very perfect ventilation, and removing any dust which might accumulate upon the face of the magnets. This dust, if allowed to remain, would be apt to cause a short circuit from winding to magnets, as one pole of the machines is to ground; as an additional precaution against this the faces of the magnets are covered with a thin layer of vulcanite.

The frame divides as in the smaller machines, and slides back on extension bases to afford access to the armature, a special engine being provided to do all this work.

Of the 10,000 horse-power dynamo, I can say but little; it will differ from the others only so far as its enormous size renders necessary. The armature will be no less than 40 feet in diameter, and will rotate at a speed of 60 revolutions per minute. It will be coupled direct to two compound vertical condensing engines, each of 5,000 horse-power, one on each side of the armature.

The shaft is the largest forging ever turned out of the celebrated Clyde workshops, and one of the largest ever made in the world. It is no less than 36 inches in diameter, 28 inches in the bearings. I really do not dare state its weight. There will be 132 bobbins in the armature, and 132 magnets on each side. The enormous size of this machine is quite beyond the comprehension of one who has not seen its parts.

The station instruments which are used in connection with the Ferranti dynamo, are the Sir Wm. Thomson gravity direct-reading ammeter, and the Sir Wm. Thomson statical voltmeter.

I will now pass on to a brief description of the Ferranti transformer, meter, etc. I am aware that I have been able to give but the merest outline of Ferranti's dynamo construction; the subject is far too intricate and wide a one to be treated at all in detail within the limits of a short paper.

Before describing the Ferranti transformer, I should say a few words about the Ferranti fuse. Its position seems naturally to be between dynamo and transformer. This is an exceedingly simple device of porcelain, having a long break. It consists of two removable plugs, to which are fastened a number of thin strands of fuse wire, according to the current to be carried. These wires pass through a narrow crevice or slot in the earthenware, from plug to plug, the crevice being broken at short intervals by cup-shaped hollows, this construction preventing arcing. The fuse has a convenient earthenware cover, can be placed anywhere, and has always proved entirely trustworthy.

The Ferranti transformer is seemingly as little known as the dynamo in this country. It is a very simple affair, of decidedly high efficiency, consisting of a number of bundles of very thin soft hoop iron, spaced apart with wedges clamped tightly together and wound at their central portion with insulation. Each strip of iron is insulated from its neighbor for half its length on each side by paper pasted on. This, when the irons are turned back, as I shall presently describe, leaves a strip of paper between each layer of iron, but does not prevent a perfect magnetic circuit.

On these bundles of irons, at the portion wrapped with insulation, is wound the secondary, which is in its turn wrapped with insulation; on to all this the primary is slipped, in the shape of a number of coils, wound elsewhere on former blocks. These coils are slipped on, one by one, and separated from one another by washers of shellaced cardboard.

The projecting irons are then turned back over the coils from each end, lapping each other, first one way, then the other, like shuffled cards, and the last two are fastened off by a simple double "L" or tinsman's joint. Half of each bundle is turned back in each direction, up and down, forming complete magnetic circuits in two directions.

The transformer is extremely convenient in case of repairs, when the irons are readily straightened out and burnt primary coils replaced.

It seems, however, to have several marked defects, the flat side of the lamination is presented to the penetration of the lines of force, which, according to Kennedy, is incorrect construction, and the transformer is inclined for this reason, both to heat rather badly, and to hum, the latter trouble being partly due doubtless to the fact that the iron cannot be held so firmly in this style of converter as in the more common type, where the iron forms a solid block.

The transformer is incased within a cast-iron shell, from which it is insulated, and into which the primary and secondary terminals are fixed by means of the Ferranti sulphur insulation.

These converters are made in five sizes: 25, 50, 100, 150 and 200 lighters. The large transformers for reducing the 10,000 volts of the primary to the 2,500 volts of the street circuits, are of the same construction as these I have just described, the insulation being, of course, increased to bear the enormous pressure.

This is not the original transformer used by Ferranti; that was of the Gramme ring type, and rather more efficient than the present one, I believe, but scarcely practical from a mechanical standpoint.

There now remains to describe only the Ferranti meter, a most ingenious recording instrument largely used in connection with Mr. Ferranti's London circuits. This meter consists of a coil, of a few turns, in series with the lamps, which passes around a core of soft iron, and terminates in a composition metal ring, which is split to prevent Foucault currents, and is bolted on to a soft iron base, being, however, insulated from it. Thus it will be seen that the ring, the base, and the soft core around which the coil passes (the lower portion of which is burnt or cast into the ring also), form, respectively, sides, bottom and top of a hollow and tight trough; the iron is continued from above the coil, by means of a horseshoe shaped laminated piece of iron which passes down outside of the coil and makes contact with the base; thus we have a magnetic pole at the top and bottom of the trough.

This trough is filled with mercury, making contact with three-fourths of the inner circumference of the ring, and the centre of the base. The current entering the coil, passes around it to the ring, and from the ring through the mercury to the base on which is the other terminal.

Under the combined influence of the magnetic field and the current passing through the mercury from centre to periphery, and *vice versa*, the quicksilver is caused to rotate.

A shaft passes from a jewel in the base, through a small hole in the iron core to a train of wheels at the top; on this shaft is an aluminum fan suspended in the bath; this is all balanced so nicely that it actually floats in mercury.

Now, since the resistance to rotation due to friction is approximately proportional to the square of the speed, and the turning moment is proportional to the square of the current, the number of revolutions performed in a given time is a measure of the current which has passed through the meter during that period.

Owing, however, to the rule of friction not following this law absolutely, and owing to the additional and irregular friction of the gear, a sensible error is introduced. This difficulty is overcome by placing a shunt coil of high resistance around the series coil, which secures an excess of electro-magnetic action, when the friction is greatest in proportion to the torque, thus assisting the low loads.

The meter is very accurate, and has a quite wide range, 1 to 50 amperes being the capacity of the 100 volt instruments; it is equally serviceable on direct or alternating circuits of any frequency.

This meter, while undoubtedly accurate, has many very apparent weak points, however; the mercury volatilizes quite rapidly, especially when the instrument becomes warm; the meters must always be kept upright or their contents will spill, and they cannot be carried from place to place without being emptied and refilled, which, as the quantity of quicksilver varies, is apt to introduce errors. In view of these troubles Mr. Ferranti is now also manufacturing and using a number of meters of small capacity, similar in principle to the well-known Shallenberger instrument, which are sufficiently accurate for general use; these are manufactured under the English patents of Mr. Wright, one of Mr. Ferranti's staff.

REPORT OF THE NATIONAL COMMITTEE ON LEGISLATION. SECTION FOR THE DISTRICT OF COLUMBIA.[1]

BY GEORGE C. MAYNARD.

It has been my special duty to look after Senate Bill No. 4,329, introduced by Senator Hale on the 15th of August, 1890, and referred to the Committee on Census.

A copy of memorials adopted at the Twelfth Convention, was mailed to all members of the Association and to Boards of Trade and Commercial bodies, from the office of the Secretary, in New York. In addition to these, 500 copies were mailed from Washington to various other persons and corporations.

Resolutions strongly urging the passage of the bill, adopted by the following-named organizations, have been presented to the Senate and referred to the Census Committee:

National Board of Trade and Transportation, New York City. Indianapolis Board of Trade, Indianapolis, Ind. Master Builders Exchange, Philadelphia, Pa. Chamber of Commerce, New Haven, Conn. Merchants Exchange, St. Louis, Mo. Retail Grocers Association, Lincoln, Neb. Commercial Club, Kansas City, Mo. Association of Edison Illuminating Companies. Norwich Board of Trade, Omaha, Neb. Wilkes Barre Board of Trade, Wilkes Barre, Pa.

In response to the memorials sent from Washington, I received from a considerable number of prominent companies and individuals replies that special personal appeals had been made to Senators and Representatives, asking their support of the bill. Accompanying these replies were copies of letters from many Senators promising their cordial support of the measure whenever it should come up.

These communications were from:

The Standard Underground Cable Co., Pittsburg, Pa., The Utica Electric Light Co., Utica, N. Y., Citizens Illuminating Co., Brooklyn, N. Y., Wheeling Electrical Co., Wheeling, W. Va., The Simplex Electrical Co., Boston, Mass., J. J. Burleigh, Camden, N. J., Wm. B. Wilson, Philadelphia, Pa., F. B. Knight, Austin, Tex., Geo. N. Stone, Cincinnati, O., M. B. Leonard, Richmond, Va., H. B. Chamberlin, Denver, Col., Geo. M. Dugan, Jackson, Tenn., Noah H. Cheever, Ann Arbor, Mich.

In addition to this work which is of record, a great deal has been done by members of the Association and others, by private letters to, or personal interviews with, Senators or Representatives.

So far as learned, not a single Congressman has made any objections to it, and nothing but the extraordinary pressure of important business has prevented its passage. It may reasonably be expected that the bill will pass at this or the next Congress.

REPORT OF THE COMMITTEE ON UNDERGROUND CONDUITS AND CONDUCTORS.[2]

BY C. H. WILMERDING, CHAIRMAN.

The committee on underground conductors begs to submit the following report for the last half year. The change which was made recently in the chairmanship of this committee, delayed to a great extent, our active work on its part. The further delay in getting our printed matter, which it was intended to send to all companies operating underground conductors, has left us without any information on the subject in hand. It was proposed to follow out the lines indicated in the report of the committee at the twelfth convention. Only one company has reported, viz: The Chicago Arc-Light and Power Co., which reports as follows:—

Miles of duct occupied by high tension underground conductors	$28\frac{1}{2}$
Miles of lead-covered cable in ducts	29
Miles of cable in iron pipes or bracketed under sidewalks for distribution	72
Total number of miles of underground high tension cable	151
Total number of cases of trouble on underground cable 1890	31
Divided as follows:—	
Result of mechanical injury	18
Result of defective joints	4
Result of defective insulation	2
Other burn-outs, cause not accurately determined	7

During the year 1890, $33\frac{5}{10}$ miles of underground conductors were laid by this company, and during that period there was one case of trouble on this $33\frac{5}{10}$ miles, the trouble being in a defective joint. They further report that their rebates during the year for defective service amounted to one-third of one per cent. of the gross earnings; and they estimate that possibly one-third of these rebates are attributable to circuit trouble; the balance to defective lamps, dynamo and engine trouble and miscellaneous causes.

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[1] Read before the National Electric Light Association, Providence, R. I.

[2] Presented at the National Electric Light Convention, Feb. 17, 1891.

The longest underground circuit is 7½ miles from pole to pole, and carries an electromotive force of 2,500 volts. They add that blizzards have not in any way affected their service.

The committee in offering this report, realizes that the information is of a very meagre character, but is of the opinion that if similar reports, or still fuller reports, should be had from all companies operating underground conductors, very interesting and instructive data could be laid before the Convention; and they request that when questions are published and sent to various companies, they will receive attention, and that the information required will be given fully and cheerfully by all those whom the circulars may reach.

THE ORGANIZATION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.[1]

BY CHAS. W. PRICE.

A FEW hours ago I was informed that owing to the absence of Mr. Worthington, I would be expected to respond to this theme—"The Organization of the National Electric Light Association." Providence with an electric light convention let loose upon it, is not the best place in the world to collect your thoughts. This, you must accept as my apology for the hurried and brief remarks I shall make, and that they are brief, no doubt, you will be thankful.

Fortunately for me, though perhaps not for the Association, I was present at the birth of the National Electric Light Association, an organization which through many changes of everything else has never changed its name, and is still known by the title given it in Chicago six years ago. I think every line of the first Constitution and By-Laws has been changed with this exception, for when other portions of the programme failed, a report from the Committee on Amendments would be depended on, and such Committee was appointed as regularly as the Association assembled in convention. These amendments were not always improvements. Having had an humble part in the construction of the first Constitution, you will understand of course I can speak from an unprejudiced standpoint.

The first convention was composed of many of the pioneers in electrical work, energetic and progressive men. Next to those engaged in electric lighting, gentlemen representing the carbon industry were the most numerous—not even excepting at that time the newspaper men—and our friends who dealt in general electrical supplies lent friendly and able aid at all times No one seemed to fully understand why the meeting had been called, one delegate stating at the first session that he came because his parent campany advised him not to.

The first meeting of the National Electric Light Association was held in the parlors of the Grand Pacific Hotel, Chicago, at 11 o'clock, a. m., February 25, 1885, six years ago. Mr. William A. Hovey, at that time one of the editors of *The Electrical Review* of New York, called the meeting to order, and stated that the call had been issued by his journal on the request of a large number engaged in the business of supplying electric light.

George S. Bowen, Esq., then with the Van Depoele Electric Company, of Chicago, was elected temporary chairman, and Mr. Henry Dwight Stanley, then, and now, and probably forever, representing the Bridgeport Brass Co., was elected temporary secretary. Mr. Bowen on taking the chair spoke briefly of the bright future he thought was in store for the electric light, remarked that the science was "still in its infancy," and expressed a confidence that valuable results would grow out of the Convention. You all agree, undoubtedly, with Mr. Bowen's predictions.

A Committee on Credentials and Permanent Organizations was appointed, consisting of the following named gentlemen: Charles A. Brown, of Chicago; C. J. Richards, Racine, Wis.; George Herbert Wadsworth, of Cleveland (since deceased); Frank Ridlon, of Boston, and S. Baldwin, of Baltimore. A Committee on Programme and Progress of Business (please note the title) consisting of about one-third of the delegates to the Convention was appointed and then we adjourned for lunch.

On re-convening, Mayor Carter Harrison, of Chicago, welcomed the visitors. Speaking from memory, I remember that he said that "Electricity was the most subtle of fluids, that it was the most powerful, the greatest agency handled by man. It was," he said, "the breath of Deity. It could rend the giant oak, melt the granite of ages, yet in the incandescent light it was as soft as down on a woman's cheek." Then we all stood up and cheered Carter Harrison.

Prof. Elisha Gray also spoke a few words of welcome, and gave electricity the credit of being the greatest wonder of the century, and varied the "infancy" remark by predicting that we were only on the threshold of its wonders. Then all applauded Prof. Gray, and everybody present felt proud of his calling.

The Committee on Permanent Organization, which had been penned up in a room, and compelled to go hungry until the report was made, then filed into the room. The peaceful look on their countenances gave no indication of the strife and controversy that had occurred in that committee room, where they had been in attendance on the birth of this Association. The Committee was fortunately a comprehensive one, and from a host of candidates made admirable selections, as follows, and the report was unanimously adopted by the Convention: President, J. F. Morrison, Baltimore; vice-presidents, H. M. Cleveland, of Hartford, Conn., J. H. Yarbrough, Nashville, Tenn., E. R. Weeks, Kansas City, Mo.; secretary and treasurer, William A. Hovey of New York; executive committee, George S. Bowen, of Chicago, William Hochhausen, of New York, Gilbert Donaldson, of St. Paul, Frank Ridlon, of Boston, John R. Fletcher, Akron, Ohio, and Geo. O'Connor, of New Orleans. Mr. Morrison thanked the Convention for the honor, and in a brief address, opened the Convention for the business that had brought many of the members hundreds of miles.

The committe on digest of papers and programme of business reported the following order of proceedings and topics for discussion, which I think will not be uninteresting to give in full here: 1. Incandescent light, particularly in regard to length of circuit upon which they can be run with profit. (You will see even at that time, these scientists and engineers were not working solely for their health.) 2. Locating and avoiding crosses with telephone wires. 3. Power and its conversion into light. 4. Electric light globes and shades. 5. The best modes of connecting dynamos with power. 6. Electric lighting by water power. 7. Rates and rebates on electric lights by the year. 8. The use of electricity as applied to motors. 9. When an electric light system requires No. 6 conductor, is it desirable to use Nos. 6 and 4 in the same line? 10. Will armatures become affected by frost when exposed in transportation? 11. Special insulation or guards to insulation of lines at dangerous points and places. 12. Street lighting—the best manner and modes of accomplishment, embracing the location of lights and running of circuits. 13. Experience and results in the use of underground conductors. 14. *Resolved*, That the firemen should receive more pay than the engineer. 15. Help generally. 16. Experience of electric light companies in the use of copper coated and uncoated carbons.

In the light of the present, the discussion which followed would prove very interesting, and in some instances laughable. But the Convention report which was published, gives you all this and I need not make lengthy mention here.

I remember that the Convention was astonished by the figures given by Mr. George Fletcher, of Dixon, Ill., of the cost to him per light. Some one asked him how much he paid his engineer. Who was his engineer? "The good lord is my engineer" said Mr. Fletcher. This he explained by stating that he employed water-power, by means of which a turbine water wheel ran a saw-mill and other mills, and incidentally his electric light plant. Mr. Van Depoele stated that electricity could be used for transmitting power. No one will dispute that fact to-day, or that Mr. Van Depoele was one of the first to prove it.

Proposition No. 9, relating to the use of the No. 6 and 4 wire in the same line, was decided in the affirmative. Whether frost could damage armatures in transportation was answered in the negative by Mr. VanDepoele.

The principal sections of the Constitution and By-Laws as adopted were as follows:—

ARTICLE II.—The members of this Association shall be companies, firms or individuals operating electric light plants or manufacturing electric lighting apparatus.

ARTICLE III.—Companies, individuals or firms engaged in the manufacture of machinery or apparatus connected with electric lighting may be admitted to associate membership by a vote of the Executive Committee. Such associate members shall pay the same dues as members, shall be entitled to seats at all meetings, but shall have no vote, shall be ineligible to office, and shall be entitled to the floor only at the request of the Executive Committee or presiding officer.

This Convention adjourned after a two day's session, and its subsequent history you are all well acquainted with.

In conclusion, it is scarcely necessary for me to speak of the great usefulness and wide influence of this Association.

Starting with a membership of less than fifty, it now has, I believe, several hundred, and it has been the means of promoting a fraternal feeling thoughout the entire electrical industry, of at once bringing to the front the most meritorious work of the alert inventors, and to an extent not easily calculable, made every electric light man acquainted with the most successful and modern manner of conducting his business. Neither can it be said to have fulfilled its mission. There is much, and still greater work to do as this great science continues to expand. No organization, and I speak advisably, has done as much to promote the best interests of the whole field of this industry as your Association.

That the good work begun in doubt and with many misgivings in the city of Chicago six years ago, may continue to still greater usefulness and honor, is the sincere wish of your present speaker.

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[1] A paper read before the National Electric Light Association, Providence, R. I.

ON THE DISTRIBUTION AND CARE OF ALTERNATING CURRENTS.[1]

BY T. CARPENTER SMITH.

I FEEL some reluctance to treating of this subject at all, because I have already spoken upon it at two or three conventions; but it has been brought to my notice that while a good deal of it is an old story to some of us, there are new stations starting up every day, and it is to those people that I address myself more particularly. I want to keep them from falling into the same holes that we fell into, and I do not think there is anything that has hurt the business more than the failures in it; I do not mean the practical or the working failures, but the commercial failures. The men who put their money into these original plans, without any knowledge, and who did it on the faith of their engineers, and who found that they did not get a sufficient return from it, are not only loath to spend any more money themselves, but they exercise a very bad effect on others when we try to influence new capital.

I will begin by stating that there are a great many points covered in the care of the alternating currents as used for electric lighting that apply with equal force to all others at present in use for commercial purposes. It is always the unexpected that happens, and no doubt many points arise in practice which are never known outside of the station in which they occur, being treated as matters of course. If, therefore, I seem to omit any point which should be covered, it must be remembered that it is my intention as much as possible to avoid recapitulation in such cases, but only describe some peculiarities of alternating current distribution which render certain precautions especially necessary and valuable.

To more easily arrive at these, it will be well, however, to briefly state the different forms of electrical currents now in commercial use and what we may call the governing characteristic of each. I leave out those which come first in the history of the question; namely, telegraph, telephone, district call and fire alarm current. They are only worthy of note for their generally poor installation, the telephone lines especially being a perpetual nuisance to all of the others. This arises chiefly from their being of such light gauges of wire that they will not stand any exceptional strain, such as is placed upon them by sleet storms or heavy gales, while the effect of rust and deterioration from atmospheric causes rapidly reduces them to the point beyond which they will not carry their own weight. I need not say that the moment they fall upon any electric light or power wires they become a menace, not only to the company operating the wires on which they fall, but themselves become dangerous to passers by in the streets who have not yet learned that any dangling wire is worthy of avoidance.

Perhaps the strongest reason why these wires are present in such overwhelming numbers in most cities is the fact that their value as "scrap" material will not pay the cost of taking them down. In other words a short sighted policy decides that it is cheaper to leave them up, and they are abandoned until they either fall down or are taken down by some other company which has reason to fear them.

The first that we consider of the currents now in general use from central stations are the "Arc Lighting Circuits." To take the most powerful current generally operated on this system we may place it at about 10 amperes, and from 2,500 to 3,000 volts on a single wire. In this current we have, as a rule, the governing characteristic of a very high tension, but with small volume; and it may be well to note the particular form of danger to which it gives rise. Its high tension makes it dangerous both as to life and fire, from its liability to leap through the insulation, and, when the current has once been started, to form a long arc. On the other hand, the danger is limited by the fact that the volume of current is small, and that the short circuiting of the line by any other conductor tends, as a rule, to simply cut the lights out, rather than to cause any great danger at the point where this happens, while nearly all the machinery of this type in general use automatically reduces the energy supplied at once.

The chief points to be guarded in these currents are therefore practically covered by the general precautions of good insulation and protection against leakage by moisture reaching the wires, while the danger to life is very largely eliminated by the usual practice of placing all lamps and appliances well out of reach of the public, and confining their care entirely to employees who are presumably skilled, and who will therefore handle the matter intelligently.

In the second great division of electrical currents which we consider, the "low tension direct current" system, the ruling feature is the large quantity. We may say that this current is practically not dangerous to life, but very dangerous as regards fire if not properly installed and protected. It is, however, a simple matter to properly protect these wires, and the low tension not putting any great strain on insulation, we may discuss it as fully covered by the ordinary rule of the fire insurance underwriters, who, in this respect, owing to the nature of the business, have even more interest in the saving of property from fire than the central station itself. The great danger, however, lies in the fact that the volume of current is so great that any short circuit on the main lines develops an enormous amount of energy at the point of accident, sufficient—on the authority of Mr. Edison himself—to reduce the pavement to a molten mass for many feet. The general public, almost necessarily, have considerable care and control of the distributive appliances and in their ignorance will often put grounds on the wires, or replace fusible plugs by copper wires; and this all has to be watched for.

And that is a danger that I think central stations ought to interest themselves more in. In Philadelphia we have got to a very good point with the fire underwriters, and they keep inspectors constantly at work; they do not merely inspect the work when it is being put in, but they go to a man's building at odd times and look all over his wiring again, and if they find any such foolishness as copper wire replacing fuses they will very often order his lights to be taken out; and it has only taken one or two instances of that kind to awaken the public to the fact that there are rights which the central station has and there are certain precautions which they themselves must take.

The third great branch, and the one with which we more particularly concern ourselves to-day, is comparatively a new one, but has in the short time it has been in existence had so phenomenal a growth that it is no wonder that we find even the commonest precautions oftentimes neglected in its use.

In the "alternating" or "converter" system we may say at once, as regards the secondary distribution, *i. e.*, from the converter to the lamp, that the rules already laid down for the installation of low tension direct current wires will practically cover the case. The alternating current of fifty volts, which practically is the standard to-day, will work successfully with insulation, and under conditions which would lead to trouble immediately with even the one hundred volts direct current; and this fact in itself often leads to poor work, either from intention or ignorance. The wiring, of course, must be proportionately heavier for this current than for the direct, which perhaps adds some slight risk of under-sized wire being used; but this is an evil which will generally correct itself, owing to the diminution in light, making itself felt before the danger point is reached. The fact also that the converter cuts off all connection between the customer and the company removes the great danger of grounds on one building affecting the whole system.

There are certain peculiar features, however, which should not be overlooked, namely, that moisture will often cause sufficient leak in the way of a short circuit to heavily overload the wires, while not sufficient to start the "dead" short circuit, which would blow the fuses. For this reason special care should be taken that the wires are properly "fused," and that in the event of a fuse persistently blowing with only its proper number of lamps, search should be made for leaks.

The general tendency in electric light business being now very largely to make the consumer responsible for all the wire upon his own premises beyond the converter, narrows the subject down to that on which I wish more particulurly to speak, namely, "High tension alternating current distribution." This current has to a certain extent the governing characteristics of both those mentioned above, and this has excited a disproportionate fear of it. Its tension of 1,000 volts (to take that oftenest used) is high enough to make a first-class insulation necessary as a precaution against leaks, which may soon break out altogether, and its being a constant potential system allows the whole power of the dynamo, or rather of the engine driving it, to be possibly developed at any point by a short circuit.

Without going into the fiercely debated question of direct *vs.* alternating currents, I would call attention to one fact. With high tension direct currents I have seen linemen, in repairing lines or cutting in circuits, handle an arc circuit of perhaps 2,000 volts when they should hardly touch it, and by taking a quick hold and keeping it, make a connection while really in a position of great danger, since a ground coming on the line elsewhere would surely kill or injure them, though they would not believe this, since they could only feel the current at the moment of taking hold or letting go. With the alternating, however, the effect is constant, and so intensely disagreeable that a very slight leak indeed will discourage any one from running the least risk on live circuits. I may mention in this connection that as far as my experience goes (and I believe some of the learned doctors agree with me) the action of a heavy shock of alternating current is to force the diaphragm up into the chest, compressing the lungs, and literally squeezing the breath out of one, causing the cry which seems peculiar to those caught in this way. If the person is stunned, dash cold water on the face and chest, loosen the clothing, especially at the neck, and use artificial respiration as for the drowned. One of our linemen who was badly caught, was brought round by these means, after being to all intents and purposes dead for nearly ten minutes, no breath or pulse being discernible.

Coming now to my subject proper, the first precaution which I think we should take in any case, is to properly lay out a system of distribution according to the circumstances of the installation. Almost the first point to be thoroughly settled is the size of unit dynamo which it is proposed to use. This should be kept as large as possible, for the reason that practically a large dynamo takes no more care to look after it than a small one, while at the same time care must be taken not to get it too large, since an underloaded dynamo and engine is not economical to run.

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[1] Paper read before the National Electric Light Association at Providence, R. I.

The second point is that as alternating current dynamos are easiest run separately and not in multiple arc, the planning of the pole lines, feeders and mains for the various circuits should be such that these units can be economically used.

Another point to be looked at in the general plan is, that, wherever possible, the sizes of the mains and feeders should be kept the same throughout, thus reducing the number of sizes of wire used in street work, and keeping the pole lines and fittings as uniform as possible. It is astonishing how few different sizes of wire are really needed if care be used in planning, for it is always a good fault to keep the sizes up, both for mechanical and electrical reasons. It must not be forgotten that, however much we may be able at the present, or have been able in the past, to control the condition under which we shall supply the public with any article, it is only a question of time when the public will decide for themselves, not only under what conditions, but in what quantities and at what prices, they will take what we have to supply.

In the early history of electric lighting, and, we may say even to the present time as far as arc lighting is concerned, the contract basis will be the one upon which the light is sold. With incandescent lighting, for many years, the contract system seemed to be the basis, but as soon as a good and reliable meter was placed upon the market, that moment the conditions were changed.

It is a part of human nature to desire only to pay for that which we use, and it is equally a part of our human nature to try and get something which we have not paid for, and for this reason there will always be those who desire the meter system and those who desire the contract system. but the weight of public opinion is so heavily in favor of the meter system that we may, to all intents and purposes, consider it as the adopted method of sale. Electric lighting is, after all, only a lighting business, and those who are concerned in the furnishing of incandescent electric lights will learn many a valuable lesson from the gas companies, who, as I have more than once reminded you at these Conventions, did not reach their present methods and conditions by having them schemed out at the start, but through much tribulation and many trials, so that their present methods are simply another instance of the survival of the fittest. For these reasons in deciding on unit sizes remember to count on probable load and not on probable number of lights rented.

To begin with the dynamos, we may say that the best unit to use will probably be found by taking the maximum all-day load. In some cases, however, this will be very light, compared to the loads thrown on during the "heavy hours," and in such cases it may be better to use a much larger machine for the sake of uniformity with its many advantages. If multiples of a unit are used, only one or two spare parts need be carried; the feeders and mains can be all laid out alike, and any dynamo is ready to take the place of any other without any preliminary cutting and changing of circuits.

The question of subdivided power is a vexed one, and one on which we can never hope to see all agreed, and I therefore do not make any suggestions beyond noting that a dynamo which can pull up its driving engine without injury to itself is a good thing; that running a small engine as a relay is cheaper than running a large one, and that, in incandescent lighting, the customer, not the central station, regulates the load. Of course, these remarks apply only to engines of the same type. I do not set a small high speed single expansion engine against a large compound or triple expansion one.

Keep dynamos well insulated, but put collectors to lead off static electricity from the belts. If there is a slight leak on one of your circuits, the easiest path for the spark may be to jump into the armature and so to line and ground, and this spark will punch through almost any insulation, and gradually keep making it weaker till some day the current generated in the armature follows the spark and your armature is gone. Look carefully to all screws and bolts; the alternating current seems to have some peculiar effect (perhaps by mechanical vibration, perhaps by actual molecular expansion and contraction) in loosening screws, causing small arcs which may melt off connections, or may make bad contacts. Nothing is more annoying than to have a dynamo operating perfectly until shut down, and then refusing to start up again. This comes often from such poor contacts—the current following and bridging over as long as it is kept going, but failing to make the first jump necessary to start. In arc lighting machinery this used to be got over by "jumping the machine," or short-circuiting it for an instant; and I have known alternating incandescent dynamos ruined by being served the same way.

A small air pump and tank with lines of pipe through the station and a hose to direct a strong jet of air into the armatures will be found a valuable addition to station equipment, and the amount of dust and copper which can be blown out after the hand bellows has done its best, is surprising.

Have your switch-board so that circuits and dynamos can be easily and quickly changed.

One feature which Ferranti seems to have early foreseen, and that is a feature which in our American practice I think has been somewhat neglected, is the use of fuses with a very much greater distance between the points of attachment, and some ready means of replacing the fuses without danger to the person so doing, even if a short circuit should still exist on the line which is being handled.

For this reason also, it is a great mistake to crowd switchboards too closely. There could be abundant room given both for the operator to stand in front of the board and to beat a hasty retreat without the danger of being caught by machinery or belts behind him, and to allow the free use of the hands and arms without the danger of being burnt by fuses in the immediate neighborhood which may go off at any time. While an alternating current will not make much of an arc when a fuse melts simply from overload, it does make a wicked and demoralizing one when a short circuit is present, especially when it has a heavy machine behind it.

There will always be some hesitation, I think, as to the adoption of devices for putting in fuses which do not have a positive contact, such as a screw connection, or one which I think Ferranti used, a plug which can be twisted in at every application, thereby keeping the contacts clean. I think, however, that we shall soon see a fuse adopted which shall be in the form of a switch which can be opened and closed as often as needed, to keep the contacts bright and clean.

In fitting up the fuse blocks and switch boards it is well to leave no points or sharp corners exposed, since the alternating current will jump from such points if it be trained across or induced to do so by the presence of the lead vapor from a fuse which has blown.

It was one of my earliest experiences to see an arc jump in this way, from the ends of wire which had been pushed so far through the connections on switches as to show their ragged points beyond the metal of the switch. The arc, which was formed on a blowing out of high tension fuse, bridged between two such points a distance of nearly ten inches and held there for some fifteen or twenty seconds, in which time it had pretty thoroughly melted up the brass parts of the switches. In this case the arc had been started by throwing in a 100,000 watt dynamo on a short circuit.

While high insulation is needed on a switch-board, which leads many to the use of rubber wire, I would say that I think a far greater danger is introduced by its use, namely, fire. On an incandescent board, fuses may go at any moment and draw a heavy arc with them. If coverings and fittings be used which will not carry flame, all is clear for new fuses in a few seconds; but if once fire starts and the other fuses let go, there is no saying where the damage will stop. While the voltage was enormously higher, and we do not know under how much more difficult conditions they labored, the destruction of a switch-board in the Grosvenor Gallery station in London, and the consequent shutting down of 30,000 lights, is a warning which all should heed.

It is always best not to have wires concealed anywhere about a station, and they should be run on porcelain or glass insulators so as to be perfectly safe from fire, even if they should be soaking wet. With wires running this way there need be no fear of throwing water on wood work which is in danger of catching fire, since the worst damage that can be done would be the blowing of the fuses from a short circuit. Of course, the covering of the wires should be of a kind which will properly protect those who are working among them. A separate ammeter and voltmeter on each circuit or feeder, while apparently an expensive luxury, is in reality a very great saving and convenience in a station which has lines over a half mile in length. The ammeter enables one to tell precisely on what feeders the load is heaviest; and where more than one feeder runs to any district it is a convenient means of knowing just upon what circuit to cut in the lights for any new customer. If the system in use allows any compensating device for indicating the correct voltage at the point of distribution, instead of in the station, it will be so much the better; and also to have on all feeders, if possible, but certainly on extended ones, some arrangement for raising the electromotive force in order that both short and long feeders may be operated from the same dynamo. Of course, there are many cases where it pays to run a separate dynamo at higher voltage for a particular feeder or set of feeders on which there is a heavy drop. But even in such cases it is often useful to be able to run these feeders with those on which the drop is small from the same dynamo.

Put pilot lamps on each feeder, which will often attract attention to a circuit being out, quicker than the voltmeter; and put pilot lamps also on each field circuit. If separately excited dynamos are used, put pilot lamps also on both the main circuit and field circuit of the exciters. These pilot lamps need not, of course, be up to candle power. High resistance lamps or lamps placed in series will be quite sufficient, and the amount of current they use inappreciable, while the saving in time which the lamps afford in case of any failure of current, by enabling an attendant to locate the trouble at once between certain points, is often considerable. Thus, if the pilot lamps on the main feeder and on the field circuit of the alternator have both gone out while the pilot lamps on the exciter mains and exciter field are still lit, it shows that the trouble is somewhere between the pilot lamps on the field circuit and the exciter mains, being probably loose contacts in the switches, or something of that kind. If the pilot lamps of the alternator only have gone out there is no use looking for any trouble about the fields or the exciter circuits, since, the pilot lamps being lit there, shows at once that the trouble is further on in the chain of connections. It may seem a refinement to put in such arrangements for the sake of saving a few minutes or even seconds, in locating troubles; but it must be remembered that the public are more and more demanding that incandescent lighting shall be as continuous and reliable as any other method, and when all the lights in a building go out at once, a few seconds delay may be a very serious matter. The public are not concerned with what the cause of the trouble may be, but only have one question, "Why do I not get the light that I pay for," and the man who rents one light is often more troublesome than the man who rents a thousand.

Separate exciting I think will be found to give the easiest handling of dynamos, and also has the advantage that as long as the alternators each have their independent rheostat, the regulation of the exciting current regulates all the lights with very little trouble.

For small stations self-exciting machines have their advantage since it gives less actual machines to look after; but I doubt whether this advantage is not more than covered by the fact that it is a simple matter to carry a spare armature for the small exciter, which can be slipped out in a few minutes, rather than to have to change the heavy armature of an alternator because of some slight trouble with its exciting coils or commutator.

While alternating current dynamos are best run separately, and the need of synchronizing is not often felt, when it is wanted, it is wanted badly; and it is a good plan to carefully speed all machines and engines so that they will all run at one speed when light, and at a certain increased speed when loaded. This can generally be done with separate engines by changing the governors, and where shafting is used, by slight changes in pulley diameters, and this will enable the dynamos to be run together, if required, with as little trouble or danger as may be.

The keeping of a careful log in boiler, engine and dynamo rooms I need hardly refer to; for some years now in the larger and better equipped stations it has been customary to weigh the coal used under the boilers and to keep an hourly or half-hourly record of the load upon each dynamo and feeder. Now, that reliable meters can be had for use on high tension circuits, I think it would be a matter of the greatest importance to have one of these meters placed in the circuit of each separate feeder, since by that means we are enabled to check up the difference between the amount of current furnished to the feeder at the station each month, and the amount of current which is charged to the various customers on that same feeder. There is nothing more than the station meter of the gas company and its value as a means of detecting leakage on the lines, whether from bad insulation or from theft of current, cannot be over-estimated.

One point we must always keep clearly before us and that is, that as long as the contract condition of selling light existed, the cost of making this light did not bear so unvariable and fixed a value with reference to the profits of the station as it does where a meter was used.

With the contract system there might be many contracts made for the use of a certain amount of light, which amount of light would not be used, resulting in a direct profit to the company; which in such cases received money for what it did not furnish, but with the meter system the only receipts of the company are for the current which is delivered to the customer and the difference in the price charged to the customer per watt hour, and the cost of producing this current per watt hour is the measure of success or failure.

It is, I suppose, hardly necessary to refer to the advantages of keeping careful records of dynamos and converters and all repairs to same. The advantage of such a system of records can only be appreciated by those who have used it. There are certain classes of machine in which armatures will last without giving a sign of trouble for from two to three years, and then one coil after another will commence giving out. It may be found that when a machine has been running for perhaps a few months and a coil gives away, that this coil may have given out from some local defect or injury in itself, and it will be worth while to repair only this coil. On the other hand, if at the end of four years a coil gives out, and then a month or two later another coil, it may pay better to rewind the whole armature, rather than to do any patching, since the chances are that the whole armature is weakened and will keep on breaking down until the whole has been rewound anyhow. The same with converters—there will occasionally be found a converter which is always in trouble. It may keep blowing fuses or burning out switch-boards continuously, and in a short time the extra cost of taking care of it would soon amount to more than a complete repair.

I do not mean to include in the regular repair book such small items as the placing of fuses; but it is astonishing how much can be learned about converters by persistently following them up. The meters which are now in general use cannot be too carefully watched. There are numerous little troubles which arise with them, chiefly from poor contacts and dust. By keeping a careful record of the readings of each meter from month to month a great deal may be learned about them, and some of the apparently unaccountable changes in their records traced up.

Among some of the minor points which must be looked out for are just to see that spiders and insects do not get into them and stop their motion; and,

Secondly, that the growth of electrical knowledge among the customers does not lead them to try to beat the meter. We have found cases where this was done by drilling a very fine hole in the case of the meter and dropping into it a fine wire, which should touch the vanes and so stop the meter recording, this being done for perhaps two weeks in the month, so as not to arouse suspicion by a total cessation of the record, while at the same time allowing a wide interval of time during which the meter inspector might call without detecting the presence of this wire.

The short circuiting of a meter has been practiced to some extent, but this can usually be guarded against by running both wires to the meter under mouldings, which as a rule the customer does not care to meddle with. In one type of meter we have seen large pieces of iron placed beside it to interfere with its record, and this will affect, I believe, almost any mechanical meter. The electric meter, being as a rule placed, like its cousin, the gas meter, in the darkest and most inaccessible spot in the building, is not always easy to keep closely watched, but if it is, a few good examples will often do away with a large measure of the trouble.

To take up the second great branch of my subject, that of the "Outside Distribution," let us return to the point where we spoke of the importance of outlining the plan and lay-out of the circuits, in connection with the decision as to the size of unit dynamo.

For the outside distribution, the first point that we have to consider is the question as to whether the wires are to be run overhead or undergrouud. Without expressing any preference for one or the other, I would mention a few points in each which should be most carefully looked after, before deciding upon the use of either. If underground work be possible, what advantage do we gain by its use? We may say that we practically get rid of all the trouble connected with storms and fire and other incidents of like nature. We also remove a great deal of the public clamor against the use of electricity, and we avoid the annoying interruption to work which goes on from the mere fact that our operations have to be conducted in full sight on the public streets. We also, to a certain extent, get a kind of claim upon premises where the current has been introduced underground, since, as a rule, the connections are not visible from the outside; and when the current has been cut off we are not required to remove them, as is often the case with overhead wires. All things considered, the maintenance of underground cables would probably be less than that of overhead wires, providing that the fixed charges due to the enormously increased cost be left out, since accidents to overhead lines generally occur together, from storms, etc., compelling the carrying of a larger force of wiremen, or a proportionately longer time to make repairs.

The greatest disadvantages of underground wires are undoubtedly the uncertainty as to their life, both from want of experience and from ignorance of the exact causes which lead to their destruction; and also that their enormous first-cost raises the cost of the production of the electric light to a point which compels us to charge the public more for their light than they are inclined to give, which fact in many cases actually prohibits its introduction. A very peculiar series of phenomena are introduced when wires are placed underground in such close proximity to one another, as they necessarily must, where a large number are run in conduits together, and these results are not very well understood so far even by those who have had the most experience with them. I may cite as an instance of this, the effect which has been observed in Mr. Ferranti's 10,000 volt mains from the Deptford station, where the electromotive force at the London end is higher than that at the generating station. There seems to be some doubt as to what causes this condition, and so far some controversy over it; though it would appear from recent utterances to be fairly well proved that it is due to static capacity, one thing seems certain, that a similar effect has been observed on some overhead lines; but in the latter case it has not been sufficient to interfere with good running.

If the overhead system be determined upon, nothing but the very best construction should be used. It must not be forgotten that the majority of accidents which have occurred from overhead wires have nearly all been caused by poor construction. I do not think I am far wrong if I say that all accidents which have occurred to others than employees of the companies have been caused either by poor construction or gross carelessness on the part of those injured. With employees the case is somewhat different. Undoubtedly many have been killed by their own carelessness, but there is a certain class of accidents which occur to the most skilled men and under the most extraordinary conditions, which must be put down simply as true "accidents," and against which no better provision can be made than by careful construction and inspection.

I think if I detailed the method which was followed in laying out the feeders for a large central station, a modification of this will probably be found applicable in most cases.

The bulk of the lighting was expected to be on two main streets of the town running parallel with one another on a long curve for about a mile and a half, and the central station was located about halfway between the centre and end of this line, and about one-half mile distant from the nearest of the two streets. There were five cross streets available, running from the central station in almost a straight line to different points of the main lighting district, and the question was raised as to which would be the best to use for running the main feeders. Approximate calculations showed that the full load of the largest machine proposed, 3,000 lights, could be carried between any two of these cross streets or feeder junctions with the maximum drop proposed, if No. 3 wire were used for the mains. It was therefore decided to use No. 3 wire continuous from end to end for the mains to start with, proper arrangements being made to cut this main into sections as fast as the load should increase so as to render the splitting up of the load on to one or more machines necessary.

To determine the size of feeders the only point raised was as to which was the heaviest wire which could be run upon poles and handled easily. It was determined that No. 0 Brown & Sharpe would best fill the conditions, and five lines of No. 0 Brown & Sharpe wire, one on each street, were run up and tapped into the mains at the junctions of both streets. The maximum number of amperes that could be carried by each feeder with 2% loss was then calculated and marked on the feeder at the switch-board and on the plans, thus: No. 1 feeder being the longest would only carry 22 amperes; No. 2 feeder would carry 40 amperes; No. 3 feeder would carry 80 amperes; No. 4 feeder would carry 65 amperes, and No. 5 feeder would carry 30 amperes. These would all run the one switch-board, and as soon as the ammeter on any one of these feeders showed that the maximum load during the nights run reached its limit a second No. 0 wire would be run on this pole line and multiplied with the first, doubling the capacity of the feeder at once. In the same way, as long as the total load on all the feeders did not reach above the first 3,000 light machine installed the mains were left continuous; but as soon as this limit was reached the mains were cut at such a point as to about divide the load into two (2) parts, and two machines were started.

This progress will be kept up indefinitely, the feeders being always kept below 2% loss and the mains cut to accommodate the unit of 3,000 lights of dynamo capacity.

The feeder which had the smallest available load, No. 1, carrying 22 amperes, happens to be the feeder which runs to the district where the fewest lights are expected, and in all probability will never be doubled up, the district being thinly populated and with no immediate prospect of its being built up very much.

In this plant another detail was introduced of making the breaks in the mains by means of switches, so that in the event of a breakdown of a feeder-line the closing of these switches would enable the lights to be taken care of by the machine on either side.

The plan in fact makes the whole system of mains one large switch-board, allowing for the transfer of lights up and down the line among the different sections.

In laying out long feeders, try and keep those which belong to different circuits as far apart as possible, since wires which run parallel with each other for long distances will cause interference, especially if the voltage of one circuit be considerably higher than that of the other, and still more if the static capacity of one be much larger. In putting in new lines be very careful to avoid the effects of induction from live circuits which sometimes rises to an unexpected degree. I have known of a case where men received a heavy enough shock to throw them down in taking hold of the bare end of a wire totally disconnected in every way from the circuit, but which ran parallel for about a half mile with a 1,000 volt feeder. Had these men been handling a bare end on an iron pole they might have received shock enough to throw them down, and injure them seriously from the fall, when we should have had another "mysterious accident" with electricity. In placing converters, while in many cases they can be placed with perfect safety inside of buildings, they can generally be placed outside in positions where they can be got at easily for re-fusing, and without disfiguring the buildings to any extent. A very good rule is to allow no porcelain insulators on out-door work; nothing but glass put on iron brackets, so made that the glass can always stand upright to prevent filling with water. No loops should be allowed to be cut in on the circuits between poles, but all connections should be made at a pole. And in the case of converters placed inside buildings, a double pole switch should be placed at this point, though I should not think it absolutely necessary in the case of converters placed outside of buildings.

Run converters separately as much as possible, and if it is absolutely necessary to run them in multiple arc keep a close watch upon the fuses, since, when run in this way, converters have a trick of blowing fuses without any apparent cause. Never change high tension fuses.

When converters are brought back to the station for storage they should be kept in a warm, dry room to prevent the condensation of moisture on the interior of the cases, which will damage them quicker than leaving them in service out of doors.

It must not be forgotten that the thoroughly sound overhead construction is the strongest argument which can be advanced to-day against companies being compelled to spend large sums of money on underground work. I have been so much interested in the pole-line work done in this city that I have examined it with some little care, and I find some points that surprise me, though I was well aware that their construction was of the best, and I relate some of these points for your consideration. All new poles are made of sawed yellow pine tarred, were sunk in the ground and painted above it, no less than 8″ square being used anywhere and the majority being 10″ and 12″.

The cross-arms are not only heavy in themselves but are rendered even more so by the kind of pins used. These are not of wood, but are made by placing a bolt with its head in the glass insulator and cementing it in solid with plaster of paris; these lag bolts being then bolted directly through the cross arms, avoiding the weakening of the arms by large holes bored into them and doing away with snapping pins.

All new wire strung is of high grade insulation, and all low grade wires whenever taken down are re-insulated with high grade insulation before being replaced. All joints in the line are soldered, and nothing but iron brackets and glass insulators allowed for outside work. Not only have the iron brackets been made for all situations, but they have been made in pairs so that the leading wires shall always be kept a uniform distance apart, which adds enormously to the trim and workmanlike appearance of the lines. I think all will agree with me that those who are willing to spend the enormous sums that such work costs have established a right to ask that they be not expected to do anything in the way of underground work until underground work has been demonstrated as successful in every way as the work that they have done here; and more than this, that such underground work shall possess decided advantages to compensate for the increased difficulty of locating and correcting trouble, in which respect the overhead line is undoubtedly far superior.

If municipalities wish to place themselves in the front rank of progress and at the same time encourage local industries, let them rather expend their energies in insisting on and compelling the proper carrying out of well-tested methods of construction rather than in demanding that untried principles and methods be experimented with, often under conditions which preclude their success.

ON ELECTRICAL MEASURING INSTRUMENTS, AND THEIR METHODS OF USE AND CARE.[1]

BY EDWARD WESTON.

IN 1881 to 1882 a proposition to place a voltmeter of excellence or ammeter of excellence in every plant or in connection with every dynamo, as was suggested here to-day by Mr. Smith, in his paper, would have been met very largely by ridicule. That was not the fault of the users as much as it was, probably, of the people who were engaged in pushing forward the commercial end of the business. The users could not be expected to understand that matter or to appreciate that if they did not use such appliances it meant considerable loss in the end.

Every instrument has its peculiarity. To speak of them generally you will find that all of them have their defects and all of them have their merits. They must all be used properly under certain conditions, in order to yield certain and accurate results. The voltmeter of the Cardew type, which is supposed to be a very permanent form of voltmeter for use with alternating or direct currents, is so extremely sensitive to changes in temperature from external sources as to make quite a perceptible error and one which would in the end cause a station considerable loss. If any one would like to satisfy himself about that, let him place such an instrument in circuit near a window through which the sun is shining, shield it from the sun's rays, turn the current on, observing the reading. Let the sun's rays fall on the tube and notice the change. I think most of you will be considerably surprised to find that the percentage of change is very large, even under those conditions. The Cardew instrument, properly used, will yield excellent results. It should not, of course, if accurate readings are desired, be placed in a vertical position. The index moves too much, and I believe you all fully realize the fact that a volt or two volts additional on an incandescent lamp enormously shortens its lifetime besides adding largely to your coal bills.

In direct current instruments it will be supposed by many persons that, because many contain no permanent magnet, their readings are not affected by their proximity to a dynamo, but that is not so. It is a very easy matter to ascertain how much their readings are affected under different conditions, but you will find that they are very seriously affected, and, in general, no instrument that is being used for the purpose of making an accurate determination should be placed near any disturbing force, either conductors carrying powerful currents or other magnetic fields, and hence this should be strictly avoided. The Cardew is less affected in that respect than some others, but it is not entirely free from that difficulty either. Those instruments that are least affected are instruments of the zero type; that is to say, where you balance a known electromotive force against the unknown electromotive force by means of a rheostat, using the potentiometer method. Those are less liable to be affected than any of the so-called direct reading instruments, but they also are affected, and their sensibility is reduced. In making readings they should never be placed very near dynamos.

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[1] Address delivered before the National Electric Light Association, Feb. 19, 1891.

Permanent magnet types of instruments which have certain very desirable qualities for general use in direct current measurements should never be taken very close to dynamos. If the magnets are properly made and the magnetic construction is good you may trust permanent magnet instruments implicity for years, providing they are used with due care. The most careful examination has revealed the fact that after three years continuous use the change has amounted to less than one-tenth of one per cent. Now how is that secured and how is it maintained? It is secured, in the first place, by very careful selection of the steel and very careful artificial aging and also in the design of the instrument.

They should not be used roughly by any means; they should be carried with extreme care and not very much jarred, because the jarring, while it does not affect the magnet at all, is likely to damage the pivots or jewels which carry the moving parts and so introduce the element of friction. This element of friction is a very serious thing in a very large number of instruments. In some the error will amount to three or four per cent.; in others it is much less.

In voltmeters there is another source of error which should be looked after particularly in some forms of instruments, very carefully. Voltmeters whose coils are wound with copper, unless they have compensators or some device for compensating for the change in the temperature of the copper are not reliable instruments to use for station work. It is commonly known, of course, that the coefficient of error of temperature is very large for copper; it amounts to about one per cent. for every five degrees Fahrenheit. Therefore a change of twenty degrees introduces an error in such instruments of about four per cent.; a larger change of course introduces an error correspondingly greater. German silver does that to a less degree of course. But even there there are serious difficulties to be met with in getting an instrument which, with a low temperature coefficient, will not heat too much by the passage of the current. So that no instrument should be sent out as a standard voltmeter, or as a voltmeter to check other voltmeters, without an absolute statement of its temperature error and some means of providing for its ascertainment. It does not suffice to notice the temperature of the surrounding air, because the temperature of the coils inside the instrument may be very different from that of the surrounding air, especially after the instrument has been in circuit a short time. The way in which electricity acts is so well understood that all those cases have been pretty well worked out, but in getting accuracy in the instruments there is a great deal to be done. Some years ago I had the good fortune to discover an alloy in which the temperature coefficient was practically nothing. We have used that to some extent—not to the extent that I should like to see it used and expect to use it later on. That alloy has given us a great deal of trouble in working. We have had to learn how to work it and I do not think we fully understand it yet; but when we get it in shape, then the temperature error will be practically entirely eliminated. How near we have approached this elimination you can judge when I tell you that in our ordinary standard voltmeters—I do not speak of the ammeter—the changes are less than one quarter of one per cent. for thirty-five degree Fahrenheit.

The type of instrument we have put on the market we never intended for switch-board use. It was intended as an absolute standard to be kept with care for checking other cheaper forms of instruments for general use. As a matter of fact no one meter, strictly speaking, exactly meets the requirements of central station work. The index does not move far enough to enable you to see the minute changes—apparently minute changes— at any reasonable distance from the instrument itself. An instrument for station work should have a very large movement for a single volt, so that a man can see such a change across the room quite readily. There have been some instruments of that type put upon the market; some had very good qualities; unfortunately some had very bad qualities. There has not been any complete solution, I think, of that problem. The nearest approach to it were two instruments, one made by the United States Company, the other by the Edison Company. Both forms had serious objections. The one did not remain constant; the other did remain, but it was a very delicate instrument and after being in a station was more or less affected, in fact considerably affected, by external influences. That problem remains to be solved, so to speak, yet, *i. e.*, to produce a satisfactory volt indicator with a very wide range for a very small change.

Ammeters are, of course, of less consequence. There is not so much loss due to change of currents as when you have the voltage changing; your lamps do not suffer quite as much. Ammeters are based, of course, upon the same general principles as voltmeters. The forms of them are too numerous, almost, to mention, and too well known to need describing. Some new forms have recently been brought out which I think, on test, will be found to be very excellent. In a station ammeter you should have at least this one element, that it should not be affected even by the most intense fields, because it has got to be placed very close to the main conductors on the switch-board. It will be of very great importance, much greater importance later on than it is now, when more machines are coupled in multiple arc, especially when alternating current machines are coupled in multiple arc. The load that each machine carries should be pretty fairly distributed amongst the various machines. To insure that, good instruments must, of course, be used. Any instrument which is seriously affected by external fields does not exactly meet the requirements of the art. Furthermore its indications should be prompt, positive —not slow in coming to rest—and always moving naturally to the same position from the same current strength and with very little magnetic lag.

Most commercial forms of ammeters, of course, are based on the action of a coil upon a mass of iron. A great many of them have a very large amount of lag. Some of them I have found with upwards of fourteen or fifteen per cent. lag put out with endorsements, and endorsements sometimes of very high authorities, as to their excellence and general accuracy. Tests show them to be just the contrary.

The ammeter question with permanent magnets is a much more serious matter to deal with than the voltmeter, and of course any permanent magnet would not do at all for alternating current work. A really portable form of alternating current instrument, similar in general character to the portable form of direct current instruments, capable of being read directly, is a very great necessity, and I think will be supplied in a very short time. Practically it is now an instrument that could be carried around with the same degree of comfort that you carry a direct current instrument.

REPORT OF THE COMMITTEE ON DATA.[1]

A. J. DE CAMP, CHAIRMAN.

THE report of the committee will be printed in two sections. Part I. will treat of the subject of "The Dangers of Electricity," growing out of the action taken at the Twelfth Convention on the paper presented on this subject by President Henry Morton, of the Stevens Institute of Technology. Part II. will treat of the subject "Standards of Economy in the Generation of Power," growing out of the action taken at the Twelfth Convention on the paper presented on this subject by Mr. H. M. Swetland, editor of *Power*, New York. Mr. Swetland has kindly consented to assist this committee by preparing this section of the report, and to present it in person:

PART I.—THE DANGERS OF ELECTRICITY.

Conforming to the instructions given to it by the Twelfth Convention, two circulars of inquiry were prepared and sent out from the office of the association to all central station companies in the United States for the purpose of collecting the statistics as desired. These circulars will be printed in the appendix of the Volume of Proceedings for this convention.

Replies to the inquiries regarding personal injuries to workmen employed by central station companies have been received from 213 companies. Of this number 45 companies failed to state the number of workmen employed, but report no accidents. 168 companies, employing 1,233 men, report 7 accidents. This report covers the year 1890. It shows that in doing 369,900 days' work but 7 injuries occurred. None of these injuries were fatal.

In the matter of fire losses, no data have been collected. I am desirous, however, to lay before the Association an extract from a report made recently by William McDevitt, chief inspector of the city of Philadelphia. It is as follows:

PHILADELPHIA FIRE UNDERWRITERS' ASSOCIATION,

136-138 South Fourth Street, Philadelphia.

Electrical Department.

There are over 5,000 buildings in Philadelphia wherein electric currents are used for light and power purposes. Of this number 287 buildings (7 of which are dwellings) have their own apparatus, the latter varying in size from a 20 light to one of 4,000 lights. The number of lights furnished by these private plants aggregate 80,258 incandescent and 3,325 arc lights. One retail store contains 482 arc lights.

There are 15 public stations distributing electric currents to all sections of the city, furnishing thousands of lights and power to dwellings, churches and other classes of buildings. The number of lights supplied by these respective stations vary from the very small station furnishing 2,000, to the Edison, which furnishes over 40,000 incandescent lights and current for a large number of motors. The electric motors in use are of a capacity ranging from ½ to 30 h. p., being used to a great extent as a substitute for laborious hand or foot power in dwellings and small workshops, and are being rapidly introduced as a more ready motor in place of steam and hydraulic power in propelling machinery.

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[1] Read before the National Electric Light Association, at Providence, R. I.

All of the different systems of electric lighting invented are, or have been, given opportunity to operate their respective apparatus in our city, and, wherever consistent with safety, approvals were given for use in insured buildings. In innumerable instances, where no insurance was held on buildings, when electric lighting was introduced, contractors were required to install the work in accordance with the Underwriters' requirements and subject to the approval of the latter's inspection.

No insurance loss occurred in any building in our city during the past year from fire where the cause could in any way be attributed to electric wires. The education of the workmen is the new factor, and the steady improvements made in materials and devices in electric appliances, have materially lessened the danger in its introduction; but a like knowledge of the inherent danger in the use and handling of electric light appliances should be had with consumers or users.

Experience has proven that no perfect insulation can be maintained with the customary method of installing electric wires, where either the conductors or the covering are exposed to mechanical injury or deterioration from affecting influences that may arise, more especially when wires are concealed in inaccessible places.

In the matter of injuries to firemen from electric current and fires caused by the same, returns made to the United States Census Office from chiefs of fire departments show the following:

TABLE IV.

Returns from chiefs of fire departments, showing number of fires and injuries to firemen caused by electric currents, compared with other similar data. For the year 1890.

Total number of towns reporting	367
" " regularly employed force	16,143
" " enrolled volunteer force	35,510
" " alarms calling out whole or part of force	30,862
" " fires caused by electric currents	363
" " injuries received while on duty	1,303
" " " " " at fires caused by electric currents	26
" " injuries caused by electric currents	25
" " fatal injuries	55
" " fatal injuries caused by electric currents	1
" " deaths from natural causes	358
" " towns in which firemen are supplied with printed rules for the prevention of injuries	1
" " towns having an electric fire alarm system	195

PART II.—ON COMPARISON OF ECONOMY IN THE GENERATION OF POWER.

The object of this work has been previously set forth in a very plain and comprehensive manner, but it may be briefly alluded to here, not only to emphasize its importance, but to enlist the earnest co-operation of the members of this Association. The committee have undertaken to record the actual cost, in towns, of coal of a definite amount of horse power actually delivered, *i. e.*, work actually performed represented by amount of electric current actually delivered, recording the results obtained from all ordinary types of equipment in use for the generation of power, more especially steam power; the idea being to show, not only the difference between the results obtained from the more modern and complete installations and those less favored in equipment, but to record the varying results obtained from each varying type of equipment under different management, making the comparison of coal with coal, boiler with boiler, engine with engine, type with type, and appliance with appliance.

These records will enable the manager of an electric plant having an ordinary equipment to compare his results with those plants operated under exactly similar conditions. To this end an inquiry circular was sent to all the central stations in the United States.

The questions asked for definite data: First, as to equipment, and second, for information regarding the time and amount of fuel required to generate a definite amount of horse power. The call has been responded to liberally by the different companies, something over four hundred returns having been received up to date, from which the foundation of this work has been fairly started, and the compilation of data received has been commenced.

Arrangements have also been made to obtain data relative to the economic generation of power in other branches of manufacturing. Results obtained in the engine room of the cotton mill, the rolling mill and various other industries, together with their special equipment, will be recorded for the benefit of comparison with the results obtained from similar equipment in electric lighting. 500 circulars to leading manufacturers have brought out a ready response, and we must confess these returns show an elaboration of detail and a conciseness of calculation which prove that the question of economy in the generation of power is not a new one to manufacturers.

The returns from the central stations are the best evidence that could be offered as an argument in favor of this work, for while many of the returns are complete, proving that a faithful record of the cost of the required power is at the disposal of the manager, a larger number of them report no tests made, or no records kept, and in several instances the whole quota of questions was answered by the very expressive and comprehensive statement, "Never mind the cost of power, we are paying dividends." Those sending complete reports often accompanied the returns with a letter of inquiry as to what others were doing with a similar equipment, expressing marked interest in the work of the committee and asking for a copy of the report when completed, and we predict that future reports from a "no data, but dividend-paying" element of these returns will in the near future withdraw their statement regarding dividends and report themselves as doing less business, or out of business, having failed to meet successfully the competition of the manager who knows what power costs and sells electric current at a fair margin of profit on that basis.

In a very few instances only, were all the questions in the circular answered. The evaporation of water per pound of coal was stated in only 21 reports. In a less number of instances was the percentage of entrained water stated, and the question relative to the number of pounds of steam used per horse power was often considered altogether too intricate and far-reaching.

Now, while answers to these questions are imperative to successfully compare appliance with appliance, all these reports which gave work performed and fuel actually consumed were useful and formed a basis of a good beginning. The main idea of the inquiry circular was, however, often lost sight of or ignored, and the question of the amount of coal used, or its reciprocal question, relative to the work performed, left unanswered, while nearly all the other questions were answered in full. However, as has been stated, sufficient data have been received to furnish the foundation of this work, and more than enough to satisfy the most sceptical of the absolute necessity of these records.

If the business of electric lighting is to be successfully conducted, a fair basis of first cost of power must be made the basis of charge for the service rendered, and if one horse power can be generated for one hour by burning one and one-half pounds of coal, the consumer of electric light will not long be satisfied to pay a profit to that electric plant whose management is satisfied to burn ten pounds of fuel for this same horse power.

The reports received in many instances show evident haste in preparation, but, as received, they convey a record of expenditure for fuel varying to the extreme mentioned above. A large number of plants are reported as burning from eight to ten pounds of coal per horse power per hour; very few, even with the modern equipment of higher expansion and condensing engines, were able to show a record below three pounds of coal per horse power, while other equipments of the same class report an equivalent duty with one-half of the expenditure of fuel.

As the inquiry circulars have only been in the hands of the different companies a few days, a large percentage of them have not yet reached the hands of the committee. It has been impossible in this short space of time to issue a complete report in time for this Convention. If the work can be continued until the next Convention the committee feel confident of being able to place in the hands of the members of this Association a report that will be of special value.

The tabulated statement of the reports received was submitted.

RATING THE CANDLE POWER OF INCANDESCENT LAMPS.[1]

BY DR. LOUIS BELL, CHAIRMAN.

YOUR Committee had not proceeded very far in the investigation of its subject before it discovered that the topic was growing, growing with a prodigious rapidity, so that we have been able to formulate, so to speak, only a partial report, a report that must necessarily leave untouched many things that we would have wished to touch, but which, we hope, embodies certain suggestions that may be of interest to those who have occasion to use incandescent lamps.

In the first place, the necessity for some rational rating of the candle power of incandescent lamps becomes evident in the experience of nearly every central station manager who has enterprise enough to keep watch of the lamps he is using. At the last Convention of this Association your president gave some admirable examples of the way in which the alleged 16 candle power lamps varied anywhere from 8 to 18 or thereabouts. Now evidently it is for the best interest both of the central station man and of the consumer that each should know exactly what is intended by 16 candle power glow lamps. It should not be left to the choice of the lamp manufacturer to make any sort of incandescent lamp he fancies and label it as of 16 candle power. There have been signs in this direction, as every station manager knows, although the manufacture of the incandescent lamp, it is only fair to say, has been very much improved of late. Now the questions that arose were about as follows: First. How shall we classify the power of incandescent lamps at all? Shall we classify it entirely by candle power, or if not by candle power to what standard shall we refer the light? or shall we classify it by watts consumed with specifications for efficiency or by watts consumed with specifications on candle power to put some limitations on the efficiency? After a considerable amount of deliberation, aided, we are glad to say, by consultations with a large number of gentlemen who are practical experts in incandescent lamp matters your committee came to the conclusion that the last mentioned method of classification was the simplest one to enforce, that is, incandescent lamps should be rated by the watts consumed, the actual power for which the consumer pays, but with a specification as to the candle power to limit the efficiency of the lamp to a practical value. By practical values I mean such as will not on the one hand produce an inordinate waste of energy, or, on the other hand, force the lamp far above its proper candle power and consequently rapidly burn it out. The interest of the lamp manufacturer evidently lies toward greater efficiency, because, by producing a very efficient lamp, such an one as will give large candle power with a small consumption of watts, he is enabled in the first place to give a fine, brilliant light that pleases customers, and in the second place to point with some pride to a real economy of power. Unfortunately, when this tendency is carried beyond a certain point, as every practical man knows, the life of the lamp is enormously shortened. A lamp that will burn from 1,000 to 1,500 hours at moderate efficiency, when forced to very high efficiency will burn a very much shorter time.

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[1] Report presented by Committee of N. E. L. A., Providence, Feb. 18, 1891.

Now, having determined the proper way, in general, of rating incandescent lamps, there arose the important question of proper limitations to be set. We have been so long used to speaking of and dealing in 16 candle power lamps, that it seems inadvisable to abandon that standard. Given then the proposition that we ought to have a 16 candle power lamp, a candle power that has been sanctioned, as I say, by very long use, what do we mean by that 16 candle power? We might define our candle well enough, but do we mean that the lamp aforesaid shall give 16 candle power maximum, 16 candles mean horizontal, or 16 candles mean spherical illumination. Your committee is emphatically of the opinion that the mean horizontal candle power should be specified; in other words, that the normal 16 candle power lamp should give 16 candle power, taking the average of the horizontal illumination in all azimuths.

Next came the question of practical limits within which the candle power might be allowed to vary; of course, if we tied ourselves down to 16 candle power, meaning thereby horizontal intensity, we would be establishing a standard no lamp manufacturer could approach; in other words, it would be commercially impossible to make a large number of lamps at a low price and have the candle power of each one exactly the same. Certain limits must be allowed. Taking the limits as they are found in actual practice, we find them 5 candle power on either side of 16, sometimes even 7 or 8. These limits your committee considered far too wide, and therefore it entered into consultation with the lamp makers for the purpose of ascertaining how close to 16 candle power the limits could be set, and yet leave the manufacturer a simple and practical process. The result of this deliberation was to settle on about 1 candle power on either side of 16, that is, on the one hand, the largest variation which we could agree to admit in defining the normal lamp, and on the other hand, being a variation which came easily within the lines of commercial manufacture.

These two points determined, next came the unfortunate question of efficiency. As to the possible efficiency of incandescent lamps giving a reasonably long life there are as many opinions as there are lamp makers, besides a few stray opinions advanced by theorists, and still fewer advanced by practical electricians. A large amount of consultation was done on this topic. Some experts in lamp matters advocated the use of lamps giving the candle power on not less than 4 watts, others loudly proclaimed 3 or 2½ watts to be quite practical and a reasonable figure. In this regard we shall have to appeal to the central station manager. Your committee was necessarily at sea to a certain extent in determining on this particular point, but after a large amount of consultation both with the central station men, lamp manufacturers and experts, it considered for general central station use, taking into account the fact that sometimes they sell light by contract and sometimes by meter, a consumption of more than 4 watts per candle undesirable, particularly if the electricity is furnished by meter, for when the consumer is paying for more than 4 watts per candle power he becomes inclined to kick, and objects very seriously to the bills sent as not representing the proper quantity of light. Then, as to the superior limits of efficiency, on how small a number of watts is it possible to produce a candle power and at the same time have a lamp of reasonably long life and having a reasonably uniform efficiency throughout its life? The very best commercial practice seems to set the figure at a little over 3 watts. Without specifying, then, the efficiency of the normal standard lamp, your committee would suggest that a lamp giving over 15 and not over 17 mean horizontal candle power on a consumption of less than 60 and not less than 55 watts, represents the average conditions of central station practice better than any other type of lamp that could be readily found. I am quite aware that in setting this 55 watt limit your committee is running in the face of opinions which are entitled to some consideration, but it would call the attention of anyone who is opposed to that limit to the fact that with the normal standard lamp thus defined, if any lamp can be produced giving a candle power with good life on a little over 3 watts it still falls within the standard. The effect in that case would simply be this: That the manufacturer who could produce a lamp giving the candle power well and steadily on a little over 3 watts could furnish as the standard lamp a lamp that would come very near to the 17 candle power limit; in other words he would get the credit of having a little brighter lamp than some of his competitors and so would not in any way suffer by the establishment of the 55 watt standard. This suggestion for the normal standard incandescent lamp is the best that your committee is as yet able to bring forward, and we trust that it will fall reasonably near the limits that most of the members of the Association have found desirable in their actual practice.

Now, as to determining the mean horizontal candle power upon which our standard lamp is to be based. Several difficulties are encountered in this work. In the first place the distribution of light that is given by incandescent lamps is not altogether uniform; in lamps with twisted filaments, particularly if of round section, the distribution is very uniform, in lamps with straight filaments of round section fairly uniform; in lamps with straight filaments of square or nearly square sections, a figure something like exhibit "A" showing the maximum at very nearly 45 degrees from the plane of the filament; when filaments of rectangular section are employed having a considerable difference between the sides of the rectangle, the light varies in the most erratic fashion. Now for all lamps giving a uniform distribution of light a single reading on the photometer is enough to determine the mean horizontal candle power, and for, so far as I know, most of the twisted filament lamps, probably all of them, a single reading will determine the mean horizontal candle power closely enough for all practical purposes. When a lamp of this description (Ex. B) is reached, a single reading might, or might not, be fair to the lamp. If the reading was taken at the point of maximum luminosity it would be altogether too fair to the lamp, because a lamp that would give 16 candle power, 45 degrees off the plane of the filament, would give nothing like 16 candle power mean horizontal intensity. Contrariwise, measuring directly off the face of the filament would be very unfair to lamps of this general construction (and there is more than one make of them on the market) while a reading off the edge of the filament will give in nearly every case a very close approximation to the average. If one has a regular photometer at hand and can make careful measurements, three readings 120 degrees apart will give an approximation in nearly every case correct within one per cent.

Now, taking the worst case of distribution, the difficulties are even greater; a very irregular circle is the actual distribution. The outer circle as shown is the mean horizontal intensity and the inner circle is the alleged candle power of the lamp (that particular make of lamp is now no longer manufactured, so we are not treading on the toes of anybody present). In such a case no reasonable combination of readings would give the mean horizontal intensity. For all practical lamps, however, nearly all of those now in use, one reading will give a very close approximation, taken anywhere in the case of the twisted filament lamps, taken either with the filament edge on, or about 80 degrees off that point, in the case of our lamps having a squareish distribution. But in lamps of more irregular character, it is only fair to say that one reading is not enough.

There is one way, however, to determine the mean horizontal candle power, and that is by spinning the lamp above an axis as it is being tested; if a lamp be mounted in a rotating socket and spun rapidly about its own axis, the mean horizontal candle power can be obtained at once, if the velocity of rotation rises to about 300 or 400 turns per minute. This process has been tried several times with more or less success. It is tried in at least one lamp factory with uniform and unvaried success, and it is certainly worth an experiment in case we have to deal with very irregular lamps which throw their light erratically around a horizontal axis.

Appreciating the fact that the average central station man has not an elaborate photometer and usually has no man whom he can readily train to do accurate photometer work, your committee suggests the use of a lamp tester, its purpose being not to measure the exact candle power of the lamp, but to see whether it falls within the standard limits. For that purpose a very cheap and simple apparatus is something as follows:

Cut a board about 7 feet long—a little over 7 feet—and at about its middle point saw one-half way through the board and stick in a piece of tin painted black, about 8 inches square, or of any convenient size, with a 2-inch circular hole cut through it. Over that hole put the photometer disc—merely a piece of thin paper with a spot of oil on it. Just 36 inches from that photometer disc place a socket which can be twisted around its axis to carry the socket of the lamp that is to be tested. At the other end of the board cut a slot and on a little slide, made in the simplest way you can contrive, set a lamp socket for the standard lamp. Make the slot of such a length that when the slide that carries the lamp is pushed into its nearest point to the screen, the lamp shall be distant $34\frac{15}{16}$ inches. Make the slot of such a length that when the slide that carries the lamp is pushed into its nearest point to the screen, the lamp shall be distant $34\frac{15}{16}$ inches. Make the other end far enough over so that when the lamp is pushed to the extreme end it shall be distant $37\frac{3}{16}$ inches from the screen. The latter position will correspond to 15-candle power in the lamp to be tested, the former position to 17-candle power in the lamp to be tested.

As regards standard lamps. If you are fortunate enough to be near a laboratory, it is not a difficult matter to get 16 candle power lamps of the voltage you use, giving preferably 16 candle power right off of the plane of the filament, as that position is more easily determined when you are putting it in the photometer. I have written personally to Dr. Duncan, of Baltimore, asking whether from his testing bureau he could furnish standard lamps. I have not yet heard from him, but doubtless that testing bureau will be able to furnish lamps to give directly off the plane of the filament 16 candle power. These would serve as a standard. With this apparatus lamp testing can be carried on with great rapidity. The lamp to be tested and the standard lamp should both be on the same circuit in parallel, consequently exposed to the same voltage; the rheostat, in series with both, so that the voltage can be brought to the point intended. Measuring instruments of any kind you have at hand will give the consumption in volts and amperes. Then, placing the lamp to be tested in its socket and turning on the standard lamp, look at the photometer disc a little from one side, standing by the lamp to be tested so that you can shift it. If the lamp to be tested then is within the standard limits, under 17 candle power, when the standard lamp is pulled to the near end of the slot, the oil spot will appear bright, lighter than the surrounding paper. Pushing the standard lamp to the farther end of the slot, this spot should appear dark, if the lamp being tested is within the normal standard; thus in testing, two positive things are to be seen, one at each end of the slot; the photometer spot should appear bright at the near end of the slot and dark at the other; if not, the lamp is not standard. This convenient substitute for exact setting I think will eliminate an error that is very vexatious. It was felt by your committee that some such device was necessary in order to prevent careless photometer work on the part of linemen and station men to whom the work might be entrusted. It is very rarely that the manager of a station himself has the time, or cares to go to the trouble of going through this testing of lamps, nor is it always practicable for him to do so. It was the intention of the committee to provide a lamp tester that would determine the maximum and minimum limits without regard to exact setting, and the charts shown will be left with the Association for reference by any of the members who desire.

LIST OF ATTENDANTS AT THE PROVIDENCE CONVENTION.

New York.—Atkinson, E. P., Ackerman, P. C., Alexander, P. H., Baldwin, C. A., Barney, Gen. C. H., Bell, Dr. Louis, Burdick, J. P., Burton, Fred G., Bushnell, Nathan, Brown, M. W., Caldwell, Edward, Colvin, F. R., Candee, Capt. Willard L., Cook, E. L., Coles, L. S. Coles, Thos. L., Chalmers, David, Cheever, H. Durant, Castle, Wm. W., Corey, R. B., DeLand, Fred, Dillont, Col. J. Frank, Ditman, M., DeRonde, Frank S., Ellinger, J. O., Fineout, W. C., Fleming, W. H., Field, C. J., Faver, A. T., Gennert, E. F., Godfrey, J. W., Gordon, W. H., Gray, R. J., Hunt, W. T., Hammer, W. J., Hungerford, D. L., Harlow, Walter C., Inglee, A. H., Irwin, J. E., Johnston, W. J., Ketchum, Joseph, Knight, F. E., Kelly, J. F., Kuhne, F. J., LaRue, Geo. W. Latshaw, Z., Leonard, H. Ward, Lufkin, H. L., Lewisohn, L., Larbig, Theo., Laehy, P. E., McCoubray, T. Manson, George T., McQuaide, Jas. P., Morrison, W. J., Mitchell, A. P., Murray, W. J., Myerson, E. Magee, Frank A., Meeker, Geo. H., Mendels, E. S., Martin, T. C., Morris, W. D., McGraw, J. H., O'Connor, T. F., Outcault, R. F., Paine, C. M. G., Platt, Willard H., Pope, Ralph W., Phelps, G. M., Pierrez, J. C., Price, Chas. W., Peck, E. H., Perot, E. S., Patrick, Fred. M., Place, Chas. A., Prescott, Jr., Geo. B., Ryan, R. W., Rosenstamm, S., Richardson, B. J., Roebuck, Thomas G., Sanford, C. E., Schieren, Jr., C. A., Seely, Jno. A., Stump, C. E., Swetland, H. M., Sheehan, W. M., Shippey, H. L., Shainwald, Ralph L., Sullivan, M. C., Smith, F. H., Sellers, W. G., Sprague, Frank J., Stieringer, L., Spilter, G. E., Schwal, Abe, Taltavall, T. R., Taltavall, J. B., Temple, W. H., Truex, C. R., Taylor, S. F., Van Nuis, C. S., Vaughan, D. W., Weinberg, Wm. J., Wetzler, Jos., Western, Benj. R., Whipple, Fred. H., Walker, G. W., Wetmore, Jean A., Wood, E. E., Walsh, Louis, Wheeler, Schuyler, S., Wilson, F., Wiley, G. L., Wilkins, F. H., Herrick, J. H., Harrington, Frank.

Boston, Mass.—Atkins, W. A., Amory, Robert, Anderson, J. M., Andrews, D. A., Jr., Austin, Geo. L., Allen, C. C., Adams, G. W., Barton, Stephen E., Brophy, Wm., Burnham, Wm., Barker, W. T., Burnham, Col. Lewis, W. Bibber, C. E., Barker, F. E., Bubert, J. F., Boyden, W. L., Burleigh, Chas. B., Blodgett, A. D., Caldwell, E. L., Cabot, Geo. E., Conant, H. J., Cram, Henry, Clark, A. T., Crane, F. H., Chase, H. W., Chase, Walter G., Cartwright, David J., Cabot, E. E., Crawford, F. A., Cobb, F. L., Claflin, A. D., Cutler, H. H., Cofren, Levi, Davis, Albert E. Davenport, G. W., Douglas, S. A., Dumoulin, L. S., Donohoe, Francis E., Eustis, Herbert H., Everts, Major Ferguson, W. B., Fowler, Chas. K., Fish, W. C., Field, A. S., Ferris, F. M., Floyd, E. D., Field, A. B., Gilley, Frank M., Griggs, A. B., Gilbert, F. A., Haskins, Caryl D., Herrick, Chas. H., Holtzer, C. W., Hill, Warren S., Hamblett, A. H., Haley, C. S., Hodges, Percy, Jenney, A. E., Key, W. S., Lynch, Lee, D. W., Lee, C. Fremont, Lovejoy, E. F., Lockwood, Thomas D., Lovell, W. L., Mason, A. F., Mason, Jas. H., Morse, G. J., Mullen, W. P., Martin, Frank A., Marks, F. H., Monks, F. H., Magee, James E., Minor, Alfred W., Pillicy, W. J., Paine, Sidney B., Preston, Jarvis F., Potter, D. F., Pettingell, F. E., Pearson, F. S., Ridlon, Frank, Ross, R. F., Roberts, G. W., Razee, L. E., Radclyffe, Herbert, Shurman, S. S., Stowe, W. E., Stillman, G. G., Smith, F. H., Sharp, E. P., Swift, H. E., Spaulding, H. C., Smith, Otis, N., Taber, R. B., Talcott, A. F., Trott, A. H., Trainer, Harry, M., Trott, Capt. S., Wheeler, Howard, Willard, Cyrus Field, Wolcott, C. W., Wallis, Louis R., Wyman, Ferdinand A., White, R. T., Warner, William D., Wilson, J. C., Wing, L. J., Hart, L. H.

Chicago, Ill.—Brown, C. A., Cutter, Geo., Cooke, W. J., Clark, E. L., Collins, W. F., Cavell, E. V., Dean, D. B., Gregory, C. E., Gilman, Lieut. H. K., Knapp, Myron A., Kreidler, W. A., Kenfield, F. L., Lucas, H. P., Mason, W. R., O'Hara, J. B., Powers, E. L., Ryan, J. C., Shay, Col. J. H., Terry, F. S., Wilmerding, C. H., Wirt, Chas., Young, John.

Albany, N. Y.—Frey, Charles P.

Ansonia, Conn.—Wallace, J. B.

Altoona, Pa.—Greene, Edgar B., Kantner, L., Markland, W. H.

Asbury Park, N. J.—Lane, Geo. M.

Atlantic City, N. J.—Harrington, W. E.

Bridgeport, Conn.—Bryant, W. C., Bullard, R. H., English, J. C., Libby, C. L., Orford, J. M., Platt, O. S., Stanley, H. D.

Brooklyn, N. Y.—Ferguson, Jas., Peck, E. F., Rich, A. F.

Buffalo, N. Y.—Abell, C. Lee, Huntley, C. R.

Bridgewater, N. Y.—Wyman, F. A.

Bristol, Conn.—Minott, F. S., Spooner, W. H.

Cambridgeport, Mass.—Hadaway, H. P.

Camden, N. J.—Armstrong, E. A., Burleigh, J. J., Robinson, Heber C.

Chelsea, Mass.—Lee, R. E.

Cleveland, O.—Cleveland, W. B., Crouse, T. B., Hayes, Webb C., Rodman, C. L.

Danbury, Conn.—Wightman, E. T.

Denver, Col.—Bradner, W. P., Law, M. D., Rollins, E. W.

Detroit, Mich.—Benton, C. A.

Dixon, Ill.—Paine, Dr. H. E.

East Orange, N. J.—Burnett, H. W.

Eau Claire, Wis.—Shaw, George B.

Fishkill, N. Y.—Watson, C. H.

Fitchburg, Mass.—Coggeshall, H. F., Kimball, A. H.

Fort Wayne, Ind.—Bradley, Charles S., Kimball, W. R.

Fremont, O.—Urquhart, D. F.

Gloucester, Mass.—Favor, L. B., Norris, E. L.

Halifax, England.—Royer, C. L.

Hartford, Conn.—Buhert, J. F., Davis, E. W., Gates, J. J., Hatch, E. B., Jewell, Chas. A., Newton, C. E., Perkins, C. G., Tolles, C. L., Wilson, F. B.

Holyoke, Mass.—Winchester, R. C.

Hope Valley, R. I.—Nichols, Willis L., Rogers, Walter.

Indianapolis, Ind.—Baugher, F. W., Jenny, C. D.

Kansas City, Mo.—Weeks, Edwin R.

Lynn, Mass.—Bates, F. C., Bubier, E. T., Draper, Paul A., Lewis, W. B., Thomson, Prof. Elihu.

London, England.—Elieson, C. P.

Manchester, Conn.—Anthony, Prof. Wm. A., Leighton, G. A., Waring, John, Gates, J. J.

Manchester, N. H.—Elliott, Alonzo.

Meriden, Conn.—Wilcox, Louis E.

Minneapolis, Minn.—Robertson, A. M.

Moncton, New Brunswick.—Dion, A. A.

Montpelier, Vt.—Blackburn, E. D.

Montreal, Canada.—Corriveau, Albert J.

Newark, N. J.—Baker, Jr., C. O., Colby, Edward A., Garver, M. M., McIntire, C. H., Weston, Edward.

New Britain, Conn.—Brady, T. H., Whitney, L. C.

New Brunswick, N. J.—Wisner, Frank P.

New Haven, Conn.—Denison, Julian F., Fowler, J. B., Fox, S. J., Warner, C. D.

North Attleboro, Mass.—Dillon, L. W., Daggett, Jr., H. M.

North East, Pa.—Daniels, A. L.

Newton, Mass.—Holmes, Wells E.

Ottawa, Canada.—Ahern, T.

Philadelphia, Pa.—Cleverly, H. A., Cope, T. J., DeCamp, A. J., Hanks, Wilbur F., Moore, Alfred F., McDevitt, W., Marshall, Norman, Paiste, H. T., Roberts, H. C., Smith, T. Carpenter, Willyoung, E. A., Wilkins, A. Ward.

Pittsburgh, Pa.—Carrier, A. E., Marsh, J. W., Young, E. P.

Plymouth, Mass.—Edes, E. L.

Portsmouth, N. H.—Flanagan, T. F.

Providence, R. I.—Arnold, Olney, Bridge, G. A., Bailey, Charles E., Buck, G. M., Barney, J. W., Carhart, E. M., Chaffee, Z., Elwell, Howard P., Fenner, H. N., Frost, Walter B., Henthorn, John T., Harris, A. Walter, Hathaway, Wm., Hughes, Edward C., Lawton, J. F. P., Lougee, Fred G., Mason, E., McKee, W. H., Phillips, E. F., Perry, Marsden J., Poole, W. H., Paine, J. B., Remington, Geo. H., Sims, Gardiner C., Sawyer, W. H., Thomas, Van A., Thurston, W. I., Hurlbert, P. J., Greene, G. L.

Rochester, N. Y.—Kaelber, I. George.

Rutland, Vt.—Francisco, M. J., Francisco, Master Don.

San Francisco, Cal.—Robinson, Leo S.

Salem, Mass.—Foster, O. A., Upp, J. W.

St. Louis, Mo.—Ayer, Jas. I., Love, W. S., Parker, G. W., Russell, D. R., Shultz, J. A. J.

Springfield, Ill.—Ide, A. L.

Syracuse, N. Y.—Clisdell, Percy, Hines, Jesse L., Leonard, F. H., Jr., Seymour, A. P.

Toledo, Ohio.—Faben, Charles R.

Toronto, Canada.—Nicholls, Frederic, Thornberry, Hy. S.

Trenton, N. J.—Murray, C. E., Perrine, F. A. C., Reed, T. S.

Utica, N. Y.—Brayton, M. J.

Waltham, Mass.—Hill, F. T. J.

Warren, Ohio.—Packard, W. D.

Washington, D. C.—Foote, Allen R., Lynch, Hon. John, Maynard, Geo. C., Royce, Fred W., Watkins, Prof. J.

Waterbury, Conn.—Mills, A. H., Shepardson, A. O., White, Leroy S., Young, A. M.

Williamsport, Pa.—Hess, G.

Wilmington, Del.—Tyson, F. C., Van Trump, C. Reginald.

Windsor, Conn.—Baird, M. E., Newton, A. D.

Woonsocket, R. I.—Lincoln, L. C.

Worcester, Mass.—Coughlin, W. H., Fairbanks, H. H., Vialle, W. H.

Ladies.—Mrs. P. H. Alexander, Mrs. Geo. L., Austin, Mrs. James I. Ayer, Mrs. Cyrus O. Baker, Jr., Miss Stella J. Barney, Miss Retta Burleigh, Mrs. Stephen E. Barton, Mrs. Henry B. Cram, Miss Clara M. Cumming, Mrs. Geo. Cutter, Mrs. A. J. De Camp, Miss Featherstone, Mrs. M. J. Francisco, Mrs. H. Gilman, Miss Evelyn Hamell, Mrs. W. R. Kimball, Mrs. E. F. Peck, Mrs. H. E. Paine, Mrs. J. B. Paine, Miss May Robinson, Miss Hebe Robinson, Miss Bella Ridlon, Mrs. Frank Ridlon, Mrs. A. O. Shepardson, Mrs. Jno. A. Seely, Mrs. Fred. H. Whipple, Miss Weldon, Mrs. Schuyler S. Wheelero. Mrs. Elmer Willyoung, Mrs. A. M. Young, Mrs. E. P. Young, Miss Young.,

THIRTEENTH ANNUAL CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

TUESDAY, FEB. 17, MORNING'S PROCEEDINGS.

President Marsden J. Perry called the Convention to order at 11:15 A. M., in Freemasons' Hall, and introduced the Hon. Charles S. Smith, Mayor of Providence, who welcomed the Association to the city.

President Marsden J. Perry then delivered the following address :—

At this, our Thirteenth Convention, we have a double duty to perform—a duty to the past, a duty for the future. We who are absorbed with dealing with the problems of to-day, and in attempting to reach a little way into the future by anticipating the demands that may be made upon us, can well afford to pause a moment to pay a fitting tribute to those whose labors in the past have made our present possible.

We are here to pay to the pioneers of the electrical industries a tribute of intelligent appreciation of intelligence, and to recognize in a formal manner the magnificent realization of the inventor's hopes and the scientist's dreams, to erect a milestone that shall mark the closing of the first decade of the practical commercial application of electricity, a development which has shown grander results than ever before known in the industrial history of the world. I ask you to step back a few years, to the time when no electrical work, as we now know it, was in existence, and from that standpoint measure the meaning and value of what has since been done.

We are told that Franklin's kite experiment was made in 1752, and that in 1753 he invented the lightning rod. The age of electricity may be reckoned from that date.

In the year 85 A. F. (after Franklin), the first electrical company in the world was incorporated by a charter granted by the State of Rhode Island. This charter was granted in June, 1838, to E. J. Mallett and his associates, successors and assigns, by whose genius it was conceived, and what became of those aborigines of the electrical age, I cannot tell you. That Mr. Mallett and his associates, whoever they were—no other name is mentioned in the charter—were true prophets of science and industry, is unmistakably shown in their marvelous conception of the possibilities of their undertaking. The third section of their charter is as follows :—

"The said corporation shall have power to cause experiments to be made in electro magnetism, magnetism and galvanism, with a view of the development of said sciences, as a motive power for machinery or other useful purposes; also, to manufacture the necessary machinery and other apparatus therefor; to build and construct boats, vessels, railroad cars and engines to be moved by electro magnetism, magnetism of galvanism." Has any one to-day a broader view of the possibilities of electric power than this?

In selecting Providence for the meeting place of your Thirteenth Convention you builded better than you knew. You not only at this time celebrate the first decade of electric lighting, but you celebrate it in the birthplace of far-reaching appreciation of electric power.

In the year 91 A. F., Morse constructed the first practical telegraph line. He connected Washington with Baltimore by telegraph in 1844. Seven years before that he exhibited his telegraph in the University of New York. Between invention and success there was seven years of working and waiting.

In the year 113 A. F., Field laid the first successful ocean cable in 1866. Eight years before a cable was laid which operated but a few weeks. Before success, there were eight years of patient, courageous work, such as man has seldom had the power to endure.

In the year 122 A. F., Bell gave the telephone to society in 1875, and made all the people of the town neighbors. His years of faithful work preceding crowning success are well remembered.

In the year 125 A. F., Brush exhibited a light that caused people to think the sun had forgotten to set at the ordained hour. The first time the public ever saw a lamp burning in series was at the exhibition of the American Institute, held at New York, September 11th to November 23d, 1878.

Two isolated plants were then sold, consisting of a six-light Brush dynamo and six series lamps. One went to Messrs. Losier & Co., dry goods merchants, of Brooklyn, N. Y.; the other went to Messrs. Freeland, Loomis & Co., Continental Clothing House, in Boston, Mass.

The first arc light Central Station was installed by the California Electric Light Co., of San Francisco, in 1879.

In the year 127 A. F., Edison divided the electric current and produced miniature suns that might be placed wherever more light was desired for use or pleasure.

The first Edison isolated plant was installed in 1880, in the printing establishment of the Hinds & Ketchum Co., Brooklyn, N. Y. A paragraph in a circular issued by this company, under date of February 1st, 1881, is as follows :—

"Our building is 40x160, four floors, lighted on all sides and fitted throughout with Edison incandescent lights, operated by a special dynamo electric machine, operated on the premises. We are the first manufacturers in the world to put into practical operation this great triumph of American genius, which is a true substitute for daylight, showing all colors in their natural hues, and our friends are invited to call and see the operation of Professor Edison's wonderful subdivision of the electric current and vacuum lamp." Mr. Hinds writes :—"I think the proudest moment of my life was when I turned on the switch for the first time and saw the room lighted up by what seemed to be the greatest wonder of the world—the incandscent lamp."

The first steamship electric plant was one of Edison's, installed with 120 lamps, in the steamship "Columbia," of the Oregon Railroad and Navigation Co., Jan. 10th, 1881.

The first Edison central station was installed with 4,000 lamps, in Pearl street, New York city, September 4th, 1882. To start this plant Edison had to overcome more than electrical, mechanical and financial difficulties. He had New York Aldermen to deal with. The following occurs in an interview with Edison, published in the New York *Herald*, January 20th, 1881 :—

"When will you be ready to light New York?" Edison replies :—"I am ready now, but we have no permit. I find it hard to get the requisite Aldermanic condition. The company laid an application before the Board, the application was referred to the laws committee, and was reported back saddled with conditions which savor of a body of gas men rather than public servants. They wanted, in the first place, the company to pay ten cents per lineal foot for all wire laid down. That would be twenty cents for every foot of street, for we would run wires on both sides. That is over $1,000 a mile. This, too, when gas companies pay not a cent. The second clause was that we should light the streets at 10 per cent. above actual cost. The third clause was that after five years three per cent. of gross receipts shall go to the city."

This is an example of encouragement given by the first city in America to American genius, skill and enterprise.

Ten years ago the only electric currents in use were the feeble currents of the telegraph and telephone. There was then not a lineman nor a workman of any kind who had ever heard of the high tension currents we are using to-day for the services of light and power. No man had ever handled conductors carrying such currents, nor manufactured apparatus for operating them excepting in an experimental way. There was not an educational institution giving a course of technical training in electrical engineering. Consider this, then behold what has been accomplished in the first decade of electric lighting. A period of time no longer than Morse, Field and Bell were compelled to wait and work to span the chasm lying between invention and practical success.

Confine your observation exclusively to the United States, and you will find the electric light in use by six thousand isolated plants. Seven hundred steamboats of American register, 350 gas companies furnishing electric light and power, 200 street railroads operated by electric power, 1,500 electric lighting and power stations. Facts like these need no embellishment to make them eloquent.

Now look beyond the limits of this country and see the development of electrical industry throughout the world during this first decade. Never before has such a transformation taken place. And this is not the end—it is but the beginning of things that are to be.

American genius, skill and pluck has, in all departments of industry, secured within this century benefits of high value for all mankind. That this truth may be known for all time, it is our duty to preserve in the most enduring and instructive form proper records of the achievements of all American industrial pioneers. Soon a fitting opportunity will present itself for the celebration of the first one hundred years, by duly honoring the beginning of the second century of the American patent system. In that grand marshalling of those who made prophecies and who fulfilled them, who had the genius to see, and the skill, courage and patience to execute, we must see to it that electrical workers occupy their rightful place of honor. The interest begun here should reach full tide then and should culminate in placing in the National Museum at Washington a collection of drawings, models, relics, etc., illustrating the birth and development of electrical industries in America. Such a collection should give at a glance to the unskilled workman or the general public an intelligent idea of successive steps of progress and invention and construction that have led from the beginning of the telegraph and telephone to those systems of communication as at present perfected, from the first production of an electric spark to the light we now have; from the first lifting of a weight by an electric magnet to the present marvelous manifestations of electric power. It is of the highest importance that such a collection be made and preserved, not alone for the instruction of the people of our own time, but as a history for all, written in the forms of the things we use, thus enabling future investigators to determine the relative influence of the electrical industries in forming the character of our civilization, and in enhancing the degree of our prosperity.

One point is worthy of emphasis while engaged in this review, his is the year 138 after Franklin. Would society consent to be placed back to the conditions it was in when Franklin made his kite experiment, if it could thereby recover from the pioneers in electrical work all that they have personally retained from the wealth that has been created by developments from their initial undertakings? No, not for a single day. They have given to society benefits a thousand times more valuable than all they have have received or that it is possible to confer upon them. Their services are of that divine order in the measuring of which money values are impotent. Limits of time and space are unknown to them. They are with us, and others, but they take cognizance of no country, no race or generation. Their field is the universe. The benefits of their service are for all men. They receive tribute of grateful honor from all intelligence. Their work is of the past. Our work is from the future. What report shall be made at the celebration of the close of the second decade of electric lighting and power? The first Edison station has increased its capacity from 4,000 to 15,000 lamps in eight years. At this rate of increase, this plant will be supplying 60,000 lamps ten years hence. We cannot measure the limits of future developments. We have done much, but we have produced only a sample of what is to be. An observer states that there is not a plant in existence having a sufficient capacity to supply one-twentieth of the demand for light and power that now exists within practical working limits of its area of distribution. If this be true, then within ten years, if each station is to fully occupy its territory, and keep pace with the growth of population, its capacity must be increased many times.

The central station men of this country do not realize the possibilities of development that lie before them. They do not see many sources of income that are as yet untouched. The accelerated pace at which progress is now moving, will render the work of the next ten years enormously greater than all that was accomplished during 138 years after Franklin. The car of progress will not stop for us any more than it did for those who were before us. We have given it momentum, but we cannot hinder it. Let it be our ambition, then, as it is our duty, to supply every demand for every kind of light and power service within reach of our stations. Those of you who do not do this will induce competitors to come within your limits, to divide your business and erect an obstacle in the way of your growth that can be overcome only by buying out, or selling to, the intruder. To-day the whole territory is yours to hold, to occupy, to serve. Be the equal of your opportunity, and at the second decennial celebration of electric light and power, the capacity of your plant may be many times what it is to-day.

The records of the beginning of the electrical industries are being written for the imperishable pages of history. We have gained the strength of the difficulties that have been overcome, like the armies of volunteers that made ours a free nation. The forces now engaged in electrical war were recruited from every vocation. To-day over thirty educational institutions of high grade are preparing the best brains among young men to do scientific and technical work. The practical American workman who has proven by what he has done that his rank is second to none, the peer or skilled workmen of the world, is educating his helpers and associates in the practical school of daily occupation.

Enterprise is ever young; we are incidents; while an industry, like human energy and force, will go on forever; when we tire and seek our rest, younger men will be eager to fill our places. Let us, then, begin where we may. Let us honor ourselves by fulfilling our double duty, which is, to duly honor those who have placed us under obligation for the work they have done in the past, and so to do our work that our successors shall have equal cause for honoring us.

The President then declared the Convention to be opened for the transaction of business.

The Secretary then read invitations extended to the Association from the following:

The Providence Telephone Co.; The Union Club, of Providence, The Providence Board of Trade, The Corliss Steam Engine Co., the Rhode Island Tool Co., the Nicholson File Co., the American Electrical Works, and the American Institute of Electrical Engineers.

Mr. C. A. Brown, chairman of the committee on Copper Tariff, reported that the reduction of the duty on copper was embodied in the McKinley bill, which became a law, and that there was now a very low rate of duty—something like 20 per cent. of the former rate of duty on copper—in its various forms. This bill having become law and this being now the duty on copper, and no further action being required at the hands of his committee, he moved its discharge. Carried.

Mr. Brown then read a telegram from Mr. J. P. Barrett, Chairman of the Bureau of Electricity of the World's Columbian Exhibition, expressing his sincere regret that he was unable to be present at the meeting of the Association.

Mr. W. H. Markland then read a paper on ELECTRIC LIGHTING AS APPLIED TO STEAM RAILROADS.[1]

Mr. De Camp inquired as to the precise conclusions reached by the Pennsylvania Railroad Company, relative to the merits of electric lighting as compared with any other form of illumination on their cars.

Mr. Markland in reply stated that the battery system which had been tried some years ago had not proved a financial success and had been abandoned except on the Pullman Chicago Limited Express, and that was lighted by batteries in connection with a dynamo in the baggage car.

Mr. J. Burleigh drew attention to the fact that in his section the Pennsylvania Railroad Co. rented their lights from his company instead of running their own plant.

Mr. M. J. Francisco stated that he had been furnishing light to the Central Vermont Railroad Company for the last two years, lighting the railroad yard, the station and the round house. Mr. Markland's theory of the best plans was the same that he had adopted in Rutland, *i. e.*, placing lights upon the tops of poles, fifty feet above the ground, with lamps on top of them. In the old style of round house in use very serious trouble was met by the soot and oil accumulating on the lamp, reducing the insulation and permeating the working parts.

Mr. R. W. Pope drew attention to the fact that one strong recommendation for the electric light on board trains was its safety, and he drew attention to the accidents liable to occur with the use of gas and oil.

Mr. A. J. De Camp stated that his experience had been, that the time spent in trying to convince the public that electricity does cost money to make it, is wasted. But when corporations like the railroad companies, who are working for their own interests and are not trying to make money outside, put themselves on record that they cannot afford to use the electric lights, solely on the ground that it is expensive, he thought it would make more impression on the community as to the real cost of the article with which the members were dealing, than anything that might be said in the matter.

The President then extended to all members of the Association a hearty welcome to the Narragansett Electric Light Company's station, and announced that on account of the large number of important papers and reports to be presented, and also on account of the memorial session, the executive committee had decided to extend the meeting so as to include two sessions on Friday, making a four day's meeting. He also announced the formal opening of the Electrical Exhibition at 8 P. M.

The Convention then adjourned until 3 P. M.

TUESDAY AFTERNOON SESSION.

The President opened the meeting by reading the Report of the Committee on Underground Conduits and Conductors.[1]

The report was accepted and the Committee discharged.

Mr. E. R. Weeks then read the Report of the Committee on Relation between Manufacturing Companies and Central Stations.[2]

Mr. A. J. De Camp in referring to the report, said: "That is all right so far as it goes, but it seems to be a sort of stereotype action on the part of the Association, and as the Chairman has stated, it is an exceedingly difficult thing to get at, even when you have a case in point to base your actions upon. I have no suggestions to make as to a line of action to be taken either in a case stated or in any other case. But the same thing has gone on, right straight along, all the time, and the manufacturing companies, with a great deal of affability find a way of avoiding it. I have had occasion, within the last year, of seeing the operations of just those movements on the part of the parent companies. The case that I have in my mind is the case in which the Thomson-Houston people are the parties who are really the aggressors in the matter. They say, "Well, of course, the Thomson-Houston people have nothing at all to do with the Fort Wayne." We of course understand that the same people are interested in it. Now they have a territory where they observe strictly their agreements with the parties who have bought the rights to their apparatus, and do nothing. They sit passively by, but they are hissing on the other fellows with all their might and main. That case was stated—the case of Campbell, which I was talking about last year. The same thing has happened in Philadelphia in the last six months. Now there is one thing that has come to my knowledge of late which I am not prepared to say anything definite about, because I have not an answer to a letter I wrote on the subject, in the case of the parent Brush Company who originally sold their franchises to several companies in the East and West under a guarantee to protect them in their patents; that is they were only able to make those deals by stating that they had fundamental patents which would protect the company paying them their royalty, or whatever you may call it, in the use of the property. It has never been worth one farthing to the company that has paid for it. A notable case of the evil effects of that has been in New Orleans, where the original company that bought its right from the parent company in Cleveland has been absolutely wiped out, and they have been wiped out because of the competition that has come in there, encouraged by the very people that started them, and they have brought suit—all of which has been noticed by you gentlemen perhaps—in a very large amount, and as far as I understand, their contract with the parent company is precisely the same as the Philadelphia contract. You can just imagine how vigorously the Brush Company in Cleveland is going to prosecute those suits against that particular lamp because it is owned by the Thomson-Houston people. I do not imagine that they are going to push that thing very hard. I do not know what reply I will get from the attorneys in New Orleans to my letter, but my idea now is this: That if the claims of that company and others who are alike situated are not recognized by the Cleveland Company and they will not prosecute those suits in the spirit in which their contract was made, it will be a very good thing for the people who are now affected and who are likely to be affected to join in that suit with the New Orleans people and make a very vigorous fight on it. And, further, that if we cannot gain a point in that way, why, take it as they have put it. They have laid claim, I think, for $300,000 damages. Now, I think some movement of that kind by the members of the Association would have a very good effect, much better than going direct to these companies; I have never got any satisfaction out of that."

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[1] See page 233.

[1] See page 239.

[2] See page 236.

The recommendation of the Committee was adopted and the report received and placed on file.

In the absence of the author, **Judge Armstrong** read the paper by F. H. **Prentiss**, on "Distribution of Steam from a Central Station."[1]

Dr. Bishop, in opening the discussion on Mr. Prentiss' paper, drew attention to the fact that distribution of steam on this plan had been successfully accomplished for more than twelve years, and that it was now employed in more than thirty different cities, besides the expensive plant in New York with which Mr. Prentiss was connected, which showed that it was a developed industry. He referred to the American District Steam Company, who constructed a short line of street mains in the Fall of 1889 for the Edison Electric Light Company in Kansas City. In the Fall of the same year the Ottumwa, Iowa, Railway, Electric and Steam Company, in addition to extensive street railway and electric lighting plants, had over two miles of street mains constructed to work in connection with their other interests. The exhaust from the engine connects directly to the street mains, which are also connected with the steam drums over the boilers. By means of reducing valves the pressure is under the control of the manager in charge, who can add live steam in any proportion required to the supply from the exhaust. They have two engines, one in connection with the street railway which runs from 6 A. M. to 11 P. M.; they run the electric light engine and dynamos during the hours required. They now have sixty-nine buildings taking steam at various points along the line, some quite large, such as the post-office, opera house, school buildings, churches, business blocks, residences, etc. The exhaust steam from the railroad engines supplies nearly all the steam required to maintain pressure in the two miles of mains to supply heat to the sixty-nine buildings. Part of the time a small amount of live steam is added. When the light engine is in use also, the present consumption does not use all of the exhaust. The pressure at the boiler house, in the street mains, is twelve to fifteen pounds. The pressure indicated one thousand feet therefrom is one to two pounds less; the pressure indicated 4,300 feet therefrom is three to six pounds less than at the boiler. These figures were taken when all buildings were taking their quota of steam, and still there was a large margin above what was required for the present consumption. At this date they had about fifteen per cent. of the probable future consumption. Another equal amount was in sight now for the coming year. Application had been made already for that increased consumption. The present earnings were, net, about thirteen per cent. upon the cost of this feature of their enterprise, with another equal amount in sight, as before stated, in the coming year which will involve no increase of expense excepting for fuel.

The apparent effect on the engines and boilers was nothing, except that twelve to fifteen pounds of extra pressure had to be carried. He also instanced the adoption of a similar steam distribution plant by the Springfield, Ill., Electric Company, and others, at Duluth, Minn., and Chester, Pa.

As to the value of the exhaust steam, he stated that each hundred horse power of boilers steaming at twenty to twenty-five pounds pressure has a capacity for heating 1,500,000 cubic feet of space, maximum. The minimum figure, allowing for all absorption of heat by engines, is 1,000,000 million cubic feet for each one hundred horse power.

Mr. A. L. Ide, of Springfield, Ill., stated that his company had made a contract with seven store buildings to heat them for five years with exhaust steam at a price averaging about $200 a year. The buildings contain about 100,000 cubic feet of space each. They did not contract for any more when they started last fall, because they wanted to be sure to have sufficient exhaust steam to supply them. They had now given about four months service which had been very satisfactory in every respect, warming the buildings satisfactorily in the coldest weather. They never have exceeded four pounds back pressure, ordinarily carrying two pounds only, and the gauge shows a reduction of about one pound at the extreme end of the mains. They estimated that the expense of furnishing this exhaust steam was trifling, and did not notice any difference in the consumption of coal required; they now found that with the surface exhaust steam they did not utilize over half. Next summer they expect to add about a thousand feet more of mains. He estimated that the receipts from steam are about one-half profit. It required no additional attendance, and it involved simply the interest on the investment on the plant and the slight additional fuel it requires.

In reply to a question of **Mr. J. A. Seely**, **Dr. Bishop** said that connection was made direct with the exhaust pipe, no drum being employed, simply a continuation of the street main. The exhaust pipe goes direct into the main. A very elaborate system of covering, of protection against condensation, was employed and a provision made for expansion and contraction of pipes. The system was known as the Holley system. The pipes could be laid at any depth in the ground; or run overhead, when necessary

Mr. Weeks said that his company had such a plant in operation now for about fifteen or sixteen months and had been very much pleased with its operation so far. They had cleared about fifty per cent. of the cost of the plant during the first year and he thought that they could considerably increase that net result by adding additional customers.

The Committee on National Insurance Rules had no report to make and was discharged.

The President recommended that a standing committee be appointed to formulate, and, from time to time, revise a code of instruction to be known and published as "Instructions of the National Electric Light Association for the Safe and Economical Wiring of Streets and Buildings for the Service of Electric Light and Power, and for the Proper Inspection and Maintenance of the Same."

This was adopted.

The Convention then adjourned until Wednesday, February 18th, 1891, at 10 A. M.

THIRD SESSION, WEDNESDAY, FEB. 18.—(MEMORIAL DAY.)

The Convention was called to order at 11:10 A. M., by the President, who drew attention to the triumphs achieved in electricity—and especially in the past decade, and which called for a fitting celebration at this time by the National Electric Light Association.

Letters of regret were read from Cyrus W. Field, Norvin Green, G. G. Ward, Alexander Graham Bell and Francis A. Walker.

The President then introduced one of the veterans of electrical service, **Mr. Thomas D. Lockwood**, of the American Bell Telephone Company, who responded for the Telegraph and the Telephone.

Mr. Lockwood remarked that while the telegraph of to-day was about fifty-five years old, nevertheless prior to that there had been numerous conceptions, but nothing practical—one of these appearing in a Latin book written by a Monk in the middle ages, and the conception, briefly stated, was that of two needles poised upon pivots and pointing to the periphery of a circle around which there were depicted the letters of the alphabet, and which would act as a dial telegraph when separated for a distance.

Mr. Lockwood then showed how the discovery, by Volta, of the galvanic pile, and that of Oersted, of the action of the current on the needle, made the telegraph of to-day a possibility.

He then passed to the early work of Morse and traced its development until success was obtained in the building of the line from Washington to Baltimore in 1844.

In this connection Mr. Lockwood drew attention to the regretable absence of Mr. James D. Reid, the veteran telegraph superintendent, who if present would have been able to relate many interesting stories of the pioneer days.

Mr. Lockwood then traced the history of the improvements upon the original Morse, and the work done on the duplex by Gintl and Stearns, the quadruplex by Edison, and on the synchronous multiplex by Delany.

Mr. Lockwood continued: "I am quite certain that I have not failed in holding out to my first view as to my ability to fill the shoes of Dr. Norvin Green. I do not feel that I have done justice to the telegraph. I am, however, a little more at home upon the next branch of my subject—the telephone. Sir David Brewster, one of the greatest scientific men of a scientific age, and who died about 24 years ago, was a Scotchman who for many years was at the head of scientific circles in England. More than once he was president of the British Association." Speaking on the telephone, Mr. Lockwood stated that some time between 1830 and 1840, Sir David Brewster had in his letters on "Natural Magic," closed a chapter devoted to automatic talking machines by saying "we have no doubt that before another century is completed a talking and a singing machine will be numbered among the conquests of science," thus showing the faith of the highest scientists in the ultimate accomplishment of what was now a complete scientific and commercial success.

Prof. Bell had realized this prophecy in the telephone which solved a double problem, namely, (1) How to make a metal plate copy the motions of all complex organs of speech ; and (2) How to make that one plate talk by electricity when that electricity was applied at a distance. He showed also how Prof. Bell was by training and education peculiarly fitted to solve this problem, which, as Sir Wm. Thomson puts it, realizes "the mathematical conception that if electricity is to convey all the delicacies of quality which distinguished articulate speech, the strength of its current must vary continuously, and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sounds."

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[1] See page 231.

Prior to 1876, said Mr. Lockwood, were not many industrial applications of electricity. Probably eighty per cent. of the persons interested in it were engaged in telegraphy, and the remaining twenty per cent. was divided between instructors of youth and persons engaged in electrotyping and electro-plating. He thought we should do all honor to the latter who, largely by rule of thumb, it is true, carried on some of the grandest uses of electricity from almost the invention of the voltaic pile in 1800 until the present time without knowing much about it, without any literature on the subject, with only five text books up to the present time which touch upon it at all, and yet who made that business a success. But all that was now changed. The civilized world glows with the illumination of electricity, the electro-motor is abroad doing our work, and the long suffering car horse and mule, are at last encouraged by the application of power to street railroads to believe that the day of spring has visited them ; while five hundred thousand telephones in the United States, and as many more in other countries attest the fact that people will, and must talk.

Mr. Lockwood emphasized the value of experiments which alone are the test of theory and speculation, and to which all the great improvements in the modern arts are due. (Applause.)

THE PRESIDENT then introduced Prof. Elihu Thomson, who responded for "Electric Lighting."

PROFESSOR THOMSON, in contemplating the work of the past few years, said that we must not fail to pay honor and tribute to Sir Humphrey Davy, the discoverer of the electric arc, and to Faraday, the discoverer of magneto-electric induction, the two phenomena which are now the bases of so many forms of apparatus. He described a visit to the Royal Institution and the difference he had noted between Davy's style of recording his experiments and Faraday's, and there was that contrast even to be seen in their work. Davy was, as it were, brilliant, jumping from one thing to another in great leaps ; while Faraday's was the painstaking work of the scientific investigator, who thought out carefully what he was about and when he had concluded his experiments wrote out just as carefully what he had obtained. The records of Faraday's were models of neatness, and precision in every way.

Prof. Thomson then traced the history of magneto and dynamo electric machines to the discovery of the invention of the Gramme dynamo, and the work of Wallace and Farmer, in this country.

Speaking of his own work in this field, Prof. Thomson remarked that he had taken up the investigation of dynamo machines about the year 1874, and had begun the construction of small models.

In 1876 he had built a small dynamo, which would run an arc light. It was his first attempt at a machine of that size, and, being successful, it led to the construction of other dynamos. When the construction of larger machines was undertaken there were difficulties to overcome, and not the least of those was the getting of steady power to run the machine. The first machine that was intended to be a commercial machine, and, in fact, the first machine which embodies the principle used in the Thomson-Houston arc apparatus—the three coil armature—was a machine capable of running four to eight lights in series. Prof. Thomson also spoke of the belief expressed by many who saw the machine, that it would require very little power to drive it, as the principle of the machine was then so little understood. This first machine was operated in a bakery, where the temperature reached 140°.

At last a company was organized which is now the Thomson-Houston Electric Company. It was organized in a modest way in the little town of New Britain, Connecticut, whither Prof. Thomson had removed. He had previously been teaching in the Central High School Philadelphia, and became electrician of this small company. Before it was organized an exhibit of apparatus was made at New Britain, in the "basket shop," as it was called, and Prof. Thomson related several amusing incidents of the troubles there experienced with the steam power. Soon another shop was obtained at New Britain and the making of apparatus for commercial use begun.

When the reverses due to the introduction of new apparatus had been overcome, the company was met by other reverses. The Brush Company saw their beginnings of success ; they were then the chief parties in the field of arc lighting. They bought up the majority interests in the little company in New Britain, apparently for the purpose of swallowing them and "laying them on the shelf." Subsequently, however, in the same year certain parties in Lynn, purchased the majority interest in the stock of what was then the American Electric Company, of New Britain, and started operations in Lynn, Mass. The Brush Company, remarked Prof. Thomson, had now been swallowed up by this infant that they tried to swallow. Such was fate. (Laughter.)

Prof. Thomson acknowledged his obligations to the members of the National Electric Light Association, in the great work which had been accomplished in so short a time, and referred to the ever-increasing business and the call for larger machines. They now had calls for dynamos up to 500 to 1,000 horse power, where, a few years ago, it was thought an unusual thing to hear a 150 or a 200 horse power machine spoken of ; and it looked very much as though in the near future machines of much larger capacity would be demanded for electric installations.

Referring to electric welding Prof. Thomson said that he did not know exactly when that art was discovered and that he believed that the formation of the National Electric Light Association was one of the steps in the process, figuratively speaking. (Applause). He referred briefly to his work in this department, which he had latterly, however, somewhat neglected for more pressing work in electric lighting.

With regard to the heating of our houses by electricity, Prof. Thomson thought it not at all likely that we will ever heat extensively by electricity, unless we can find some way of converting the energy of coal into electricity far more directly and less wastefully than is done in steam engines of the present day.

Referring to the previous day's discussion on the utilization of the waste steam from electric light plants for heating purposes, that seemed to be a direction in which much valuable work could be done.

In regard to the electric railway, Prof. Thomson hoped to live to see the time when some of our larger roads will be in operation as they should be, and can be, by electricity. He hoped also that the time might come when we shall have at our command an easy, direct method of obtaining electricity from fuel.

The President then introduced Mr. F. H. MONKS, General Manager of the West End Railway, of Boston, who spoke on "Electric Railways."

MR. MONKS briefly reviewed the early railway experiments of Davenport and Hall, and rapid strides that had been made during the last few years. Mr. Monks first saw the electric railway at Richmond, where he became thoroughly convinced when he saw what was being done there by Mr. Sprague and his fellow workers. He also related several curious experiences of the early days of electric railroading.

On the first day of January, 1889, after several months of preparation, the first electric car was started under the Sprague system, in Boston, and later the Thomson-Houston system was put in operation by the West End Company, in Cambridge. Since that time there had been no backward step and there had been continued and renewed expressions of opinion both by the officials of the company and by the public generally, of confidence in the system of propulsion of street cars by electricity. Mr. Monks expressed his doubts as to practicability of storage traction.

They had difficulties in Boston, of course, but they had also a glorious history to record in what had been accomplished. Last summer, during the visit of the Grand Army to Boston, they carried on their entire system, 3,000,000 passengers in one week, and of these more than one million were carried on the electric cars, without the slightest hitch of any kind, without any trip being missed and without any person being injured in any degree. (Applause.) At present they have sixty miles of electric track and are operating over three hundred cars. They are running about 18,000 car miles a day electrically or about three-quarters of the distance around the globe and carrying from 100,000 to 125,000 passengers daily by electricity. The experiment, if such it may be called at this late date, in Boston, had passed to a stage where the public not only consented to its extension, but actually demanded it. From all quarters of the very large area covered by the road with its two hundred and sixty miles of track, they had constant demands for the immediate introduction of the electric system ; so that where it had been a matter of grave difficulty heretofore to pacify the public mind respecting the matter of the introduction of electric roads, with them in Boston, it became now simply a question of not getting in too quickly.

Mr. Monks considered it advisable to go somewhat slow in the extension of electricity on his road, in view of the fact that electric railroading is still undergoing rapid changes in details of mechanism.

Mr. Monks, after careful consideration, was very strongly of the opinion that the future electric street railroads will not have their motors under the car. He did not believe it is possible for a motor to be built to be used under the car which would give that degree of life and durability which the rough usage of a street railroad is bound to impose on it. He thought, on the other hand, that the electric locomotive or motor car would be the solution of the problem. For many reasons the electric locomotive was decidedly preferable to the use of motors under a car. The first one, and perhaps, the most important was the fact that in Boston, Providence, Worcester, in fact, all the large New England cities, a double equipment of winter and summer cars was necessary. He doubted whether any street railroad could afford to buy electric motors with all the electric machinery incident thereto for two equipments, one for the box cars and one for the open cars. When electric railway engineers would come forward with practical scheme whereby the double motor equipment could be a avoided and something that could be depended on to work every day through 365 days in the year, they would be met with open arms

THE PRESIDENT then introduced Professor J. Elfreth Watkins, curator of the Smithsonian Institution in Washington, who read a paper on the "Place of Electrical Invention and Development in History." It was an able summary of facts familiar to electricians.

MR. R. W. POPE then offered the following resolution :—

Resolved, That the National Electric Light Association, assembled to celebrate the decennial anniversary of the establishment of the electric lighting industry in the United States, fully appreciating the value of the discoveries and inventions of Joseph Henry, heartily approves of the proposition now before Congress to bestow substantial recompense upon the daughter of the great discoverer who, during a life time devoted to science, received no financial compensation for the benefit he conferred upon mankind.

Resolved, That a copy of these resolutions be forwarded to both Houses of Congress.

The resolutions were unanimously adopted by a standing vote.

MR. E. R. WEEKS drew attention to the fact that in Kansas City where the oldest Thomson-Houston central station is located, they were still operating some of the original ten-light machines built by the original American Electric Company in the old factory in New Britain, mentioned by Professor Thomson.

THE PRESIDENT then introduced Mr. J. H. Herrick, first vice-president of the Edison General Electric Company, who, in the absence of Mr. Edison, spoke on "Incandescent Lighting."

MR. HERRICK expressed his inability to fitly represent Mr. Edison, and briefly reviewed the history of incandescent lighting, and showed how the substitution of the high resistance filament for the low resistance, previously worked upon by many, had made incandescent lighting possible. Mr. Herrick emphasized the fact that no man was fit to belong to the electrical fraternity who did not believe in the scientist's dreams. (Applause.) What we had achieved in the past was largely owing to the dream put into reality, of our scientists. What we may expect in the future will depend upon by how much faith, by how much energy, by how much genius, we endeavor to realize the dreams of the scientists.

MR. E. W. RICE, JR., supplemented the remarks of Prof. Thomson, by some interesting reminiscences of Prof. Thomson's early work. He related how, when he visited the Central High School, at Philadelphia, one afternoon after school to examine some of Prof. Thomson's old works, he saw there a dynamo which the Professor assured him was the first one that he had ever built. This dynamo, curious to relate, was so wound and connected by Prof. Thomson on different occasions that it involved many of the principles which have since become well known, but which at that time were unknown. He had the winding so arranged that the machine could be used in shunt, in series, and in series-shunt, which was practically known to-day as the compound winding, and which was now used so extensively. Prof. Thomson did not publish it at that time, for the reason that he did not consider it to be a particularly important piece of work. Prof. Thomson had done a great many things of this kind that were equally great but which seemed to him so ordinary, and such matters of course, that he neglected to say or do anything about it.

Mr. Rice related his early experience in the service of the Thomson-Houston Company from its inception, and the easy times then had, as compared with the ceaseless work now demanded by the business.

MR. GEORGE M. PHELPS then presented the following resolution

Whereas, The members of the National Electric Light Association assembled in its Thirteenth Convention have learned of the serious illness of Mr. George Worthington whose genial presence is missed by all, and whose conspicuous services to electrical industries in promoting the organization of the Association is recalled by all, it is

Resolved, That the Association hereby express its cordial esteem for Mr. Worthington, its appreciation of his many services and its heartfelt wishes for his early recovery of health and strength, and that the Secretary be requested to forward a copy of the resolution to Mr. Worthington.

The resolution was carried unanimously.

THE PRESIDENT then introduced Mr. FRANK J. SPRAGUE, who responded for "The Utilization of Electric Energy for Power Purposes."

As personal reminiscences were in order, Mr. SPRAGUE recalled to mind the fact that in 1879 he was on duty on board of a naval vessel of the United States on the coast of Japan. He had before that time been at the Naval Academy, graduating there in 1878, and just at that time Edison, Bell, and other electricians were prominent in the field, and there grew up in his mind a love for electrical matters and the desire to be associated some way with electrical developments. The United States Navy department at that time was not very encouraging to any such ambition. He went the way of all other midshipmen and drifted out to Asia, but the stories came of the discoveries being made in electric lighting by Thomson and Brush, and he became very nervous. Even at that time he was trying to invent an electric motor, and finally obtained permission to return to the United States in a sailing vessel. Arrived here, he went to Ansonia, Conn., and saw an experiment in the transmision of power which greatly impressed him. Mr. Sprague pointed out that Mr. Wallace, of Wallace & Sons, of Ansonia, was a man whose position in the history of this enterprise had never been fully appreciated. Mr. Wallace had one of the old four-pole armature machines, connected with a dynamo. He turned on the current and soon the machine was running two or three thousand revolutions a minute, and then deplored the fact that it was of little or no value as it slowed down and stopped when a brake was applied. He had overlooked the most important fact that he had to deal with, viz., that the energy developed was made up of two factors, namely, the torsional effort and the speed at which the armature revolved. Later on Mr. Sprague experimented with a Wallace-Farmer machine at the Brooklyn Navy Yard, but his duties soon called him out of the United States, and it was not until 1882, at the Electrical Exposition at London, that he was brought to a consideration of the tremendous advance that electricity was making.

Speaking of his early electrical railway work, Mr. Sprague said that few were familiar, perhaps, with the inside difficulties with which he had to deal. The contract for the road in Richmond was taken in 1887. He had never seen the road, and remembered to this day, the impression that came over him. He had been talking with John Stephenson, the pioneer car builder of the United States, and who said, "I do not believe that any self-propelling car can operate under street car conditions. I am acquainted with fourteen of them in the city of Paris." Mr. Sprague's answer to this was that there had been one difficulty with those, namely, that not one of them utilized the weight of the car for the purpose of traction. The first tractors that were built by Mr. Sprague were built for storage battery experiments on the West End railway, in Boston. Subsequently when he went to Richmond he saw a grade of 10 per cent. This, everyone predicted, could not be successfully mounted by an electric car, but after almost insuperable difficulties, and not a few amusing incidents, complete success was finally achieved, and the practicability of electric railroading, on a commercial scale, completely demonstrated. Mr. Sprague here paid a glowing tribute to the industries of the city of Providence, and referred to the fact that the success finally attained in Richmond was largely due to materials and work furnished by Messrs. Brown & Sharpe, the Armington & Sims Engine Co., the American Electrical Works, and the Bridgeport Brass Co., of Bridgeport, Conn.

As to the future of the electric railway, Mr. Sprague had heard with some interest what Mr. Monks had stated. The latter's objections to the double equipment had been based somewhat upon the cost. Mr. Sprague referred to the changes that the electric lighting apparatus had passed through, and none could doubt from the changes that electric railway apparatus had gone through, that it was going to be made more simple, lighter, stronger, more reliable and at much less expense; so that the objection which Mr. Monks raised was not an entirely sound one. It was based upon past results not upon future promises. The gearing of the present motor, Mr. Sprague said, would disappear from the electric motor of the future, and it was a very near future. It would also be an electric motor driving direct without any reduction whatever. Its revolutions would be coincident with the revolutions of the wheel. The day of the gearing was fast disappearing, and those who had had experience with gears on electric motors could surely feel encouraged by that fact.

Of late Mr. Sprague had been in exactly the position of Prof. Thomson, in which the infant swallowed up the larger specimen, and he had always been very much in the position in which the infant got very thoroughly swallowed up. Regarding the electric railway problem in New York city, the question of rapid transit is coming to the front. That New York would eventually have electric railway transit no man who knew the future of this industry could doubt. Exactly what form it would take no man could tell. While he was an advocate of one wire, if necessary, overhead, Mr. Sprague said he was an advocate of everything being put underground as far as possible. He did not believe in the theory of God's free air in New York city, where the air is monopolized by three things—buildings from 10 to 14 stories high, the elevated railroads, and the Bell Telephone Company. But he believed in God's free earth, where one could go independent of grades and independent of weather conditions. There was a most remarkable example of the perfection of that method of operation in London, and his prediction of its complete success, based on a visit some time before the starting of the City and South London railway, had been fully justified by the results now obtained.

MR. F. S. TERRY, of Chicago, then gave some reminiscences of the organization of the Association at Chicago in 1885.

The meeting then adjourned.

AFTERNOON SESSION, WEDNESDAY, FEB. 18.

Invitations to inspect plant and buildings were received from the Providence Steam Engine Co. and the Young Men's Christian Association.

THE PRESIDENT: The first item on our programme this afternoon is a paper by Prof. Elihu Thomson on the Electrical Arc and its Use in Lighting.[1]

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[1] See page 225.

Prof. Thomson then read his paper. He was followed by Dr Louis Bell, who reported from the Committee on the Proper Rating of Incandescent Lamps.

The President: Are there any remarks on this subject? As there does not seem to be any, the next business will be a report from the Committee on Legislation, and Judge Armstrong will make the report.[1]

REPORT OF COMMITTEE ON LEGISLATION.

Judge Armstrong: In making the report of this committee, I will state that it was the idea at the outset to have a representative on the committee from each State in the Union, to receive, at the headquarters of the Convention, the secretary's office, a report of all matters of legislation, pending in the various State legislatures. Very few, if any, of these reports, have been received. So that I presume it is safe to apprehend that very little legislation outside of the ordinary course has been, or is being, attempted. The most of the State legislatures being now in session, of course the report cannot be and is not as full as we would be able to have it at a summer convention. In our own State, New Jersey, the regular line of bills to bury all wires underground, to put them 100 feet above the ground, and to carry them along in various ways, are always there. (Laughter.) They have a peculiar name, not entirely complimentary or polite to the legislatures to call it, and so in my report I will say nothing about what we usually know them as. (Laughter.)

In making this report I presume we all, as representatives of companies, must remember that we have more than a commercial duty to perform. No electric light company, supplying light, can claim to be entirely or solely an independent business corporation. Every one of us has assumed for his company certain public duties and responsibilities. When my company engages to light a city it has engaged in a very serious responsibility. We, therefore, are more or less reasonably subject to legislation and legislative enactments, from municipalities, as well as from States and State legislatures. Being so, there is grave danger, however, that that same license, same power, properly given, may be carried to dangerous and injurious accessions from mistaken zeal, or other reasons.

I have a report here from Mr. George C. Maynard, from the District of Columbia, in which he says:

REPORT OF THE NATIONAL COMMITTEE ON LEGISLATION. SECTION FOR THE DISTRICT OF COLUMBIA. BY GEORGE C. MAYNARD, MEMBER OF COMMITTEE.

It has been my special duty to look after Senate bill, No. 4329, introduced by Senator Hale on the 15th of August, 1890, and referred to the committee on census.

A copy of memorials adopted at the Twelfth Convention, was mailed to all members of the Association and to boards of trade and commercial bodies, from the office of the secretary, in New York. In addition to these, 500 copies were mailed from Washington to various other persons and corporations.

Resolutions, strongly urging the passage of the bill, adopted by the following named organizations, have been presented to the Senate and referred to the census committee: National Board of Trade and Transportation, N. Y. City.; Indianapolis Board of Trade, Indianapolis, Ind.; Master Builders' Exchange, Philadelphia, Pa.; Chamber of Commerce, New Haven, Conn.; Merchants' Exchange, St. Louis, Mo.; Retail Grocers' Association, Lincoln, Neb.; Commercial Club, Kansas City, Mo.; Association of Edison Illuminating Companies; Norwich Board of Trade, Omaha, Neb.; Wilkes Barre Board of Trade, Wilkes Barre, Pa.

In response to the memorials sent from Washington, I received from a considerable number of prominent companies and individuals communications stating that special personal appeals had been made to Senators and Representatives, asking their support of the bill.

Accompanying these replies were copies of letters from many Senators promising their cordial support of the measure whenever it should come up.

These communications were from: The Standard Underground Cable Co., Pittsburgh, Pa.; The Utica Electric Co., Utica, N. Y.; Citizens' Illuminating Co., Brooklyn, N. Y.; Wheeling Electrical Co., Wheeling, W, Va.; The Simplex Electrical Co., Boston, Mass.; J. J. Burleigh, Camden, N. J.; Wm. B. Wilson, Philadelphia, Pa.; F. B. Knight, Austin, Texas; Geo. N. Stone, Cincinnati, Ohio; M. B. Leonard, Richmond, Va.; H. B. Chamberlain, Denver, Col.; George M. Dugan, Jackson, Tenn.; Noah H. Cheever, Ann Arbor, Mich.

In addition to this work, which is of record, a great deal has been done by members of the Association and others, by private letters to, or personal interviews with, Senators or Representatives. So far as learned, not a single Congressman has made any objection to it and nothing but the extraordinary pressure of important business has prevented its passage. It may reasonably be expected that the bill will pass at this or the next Congress.

The Illinois Electric Lighting Association has sent out to its various companies a circular referring to matters of legislation in the State Legislature of that State, which is now engaging their attention as follows:

Illinois Electric Lighting Association.
53 Dearborn street, Chicago, Jan. 17, 1891.

Gentlemen: An effort will be made at the present session of the State Legislature to pass a bill authorizing cities and towns in Illinois to operate electric lighting and power plants for the purpose of commercial, as well as municipal lighting.

The injury to our mutual interests which would result from any such legislation is too apparent to call for special comment. One and all of us who have investments in electrical central stations are deeply concerned in the defeat of any measure which so palpably aims at our very existence. The urgency of the situation demands immediate and united action on the part of all concerned in electrical distribution. The passage of such a bill means the practical destruction of our capital, and if any efforts on our part can avail to thwart this movement, now is the time to put them forth for the sake of preservation.

If each one of us will use the influence he may be possessed of with the local representative to the Legislature, and if each company will lay the facts before the Board of Directors and induce them to bring the weight of their arguments to bear upon our Legislators, it is possible that the designs of the demagogues may be frustrated.

The Illinois Electric Lighting Association was organized with a view to just such an emergency as this. The responses to the calls which were sent out at its inception were very few in number, probably because at that time the central stations throughout the state did not appreciate how soon they might be called upon to act in concert. Small as the Association is, however, it proposes to do all that it can, but it is evident that its work would be much more effective if it were more representative of all the central stations in the state, and it is suggested for your consideration that you take the matter of joining the Association once more under advisement. In the meanwhile it is imperative that the personal efforts of everybody interested be exerted toward the defeat of the proposed action of the Legislature.

The acknowledgment of this letter and a statement of just what you can and will do to this end will be appreciated and will probably greatly aid in accomplishing the work we have before us.

Yours truly,
C. H. Wilmerding, President.

May I urge upon the representative of the companies here, particularly those who may be upon this committee, that they will take pains to send any information concerning the matters of legislation. In the report of our proceedings the secretary has compiled here all matters that he may get hold of relating to legislation before our various State Legislatures and what was done with various projects. There were some mighty novel projects introduced, and this will show what has been done. There are some interesting matters which have been, and are being, considered by the New York State Legislature, and also by the legislature at the present time in the State of Massachusetts. There will be found some very interesting reading in this book for those who are concerned, as we all are, in these matters, and who may all be concerned in these various items of legislation.

I suppose that Massachusetts has had the most uncomfortable experience lately of any of the states. Mr. Everett W. Burdett, who is the attorney of the Massachusetts Electrical Association, of Boston, is here to-day, and he will make a report upon matters in the Massachusetts Legislature. Mr. M. J. Francisco, from Rutland, will, I believe, make a report of what has been done in Vermont. Now, if we can get to the secretary all of the bills and measures that are pending before the various State Legislatures, and a statement of what has been done concerning each of these things, it will make in time a very valuable library upon this one point.

Mr. Edward W. Burdett, of Boston: I may premise the short report which I shall read with a statement, which I dare say will be disputed by nobody, and that is that in Massachusetts we have now, and have had in the past, more attempted legislation to the square inch than any other community, large or small, within the boundaries of the United States. Our experience has not been as yet painful, because nothing has been accomplished of any account upon the other side, but it has certainly been interesting, and I think it will be instructive to those representing this interest in other states. Referring for a moment to what has been said by the chairman of your committee—and I appear here in the place of Mr. Gilbert, who is a member from Massachusetts, and at his request—I may say that last year, and this, we have had printed a copy of every order or suggested law which is pending, or has been pending, before our Legislature, and that has been sent to about five hundred persons in the State directly interested in the industry, and in that way we have spread throughout the length and breadth of Massachusetts accurate information as to what was on foot, and followed it up, as I did yesterday, for the year 1891, with brief statements of reasons which should be given adverse to the proposed legislation. I think the list of subjects which were before the Legislature of 1890 are printed in the volume of the Association's last Convention, although I have not had an opportunity to examine it, and the same matter has been printed for the year 1891, within a day or two, and is to be distributed forthwith.

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[1] See page 246.

The matters affecting electric lighting interests which were before the Massachusetts Legislature of 1890, are reported in the proceedings of the last Convention of this Association. They consisted of sixteen orders and numerous petitions, upon all of which action was had by committees of the Legislature. The only law which resulted from this agitation, was Chapter 404 of the Acts of 1890, relating to the regulation and supervision of wires over streets or buildings in cities. This act requires the suitable insulation of all wires at points of attachment, strong and suitable supports, the removal of all abandoned wires, appliances calculated to prevent currents of electicity capable of injuring electrical instruments or causing fire from entering buildings, and the tagging or marking of each wire or cable so as to designate the owner or user thereof. It further provides for the appointment of an officer to supervise all wires in cities, to remove abandoned wires, and generally to have the supervision of the use of wires.

There is pending before the present legislature a proposition to extend this act to the towns as well as the cities of the commonwealth, and to enlarge its provisions in its application to the city of Boston.

The agitation in favor of the enactment of a law to permit municipalities to own and operate gas and electric light plants resulted in a bill which was passed to be engrossed by the House, but it was referred by the Senate to the Legislature of 1891. This bill is now pending before the present joint committee on manufactures. While this bill was pending in 1890 the House of Representatives required the opinion of the justices of the Supreme Judicial Court upon the questions whether it was within the constitutional power of the Legislature to enact a law conferring upon cities and towns the power to manufacture electric light for use in the public streets and buildings of such cities and towns, and for the purpose of selling the same to their citizens. Both questions were anwered in the affirmative. The decision mainly turned upon the question whether the manufacture and distribution of gas and electricity by cities and towns for illuminating purposes is a public service within the meaning of the Constitution (part II, chap. 1, sec. 4). The Court held that the maintenance of public streets and buildings is a public service; that they may be lighted at the public's expense; that the means of lighting are a matter of expedience; and that the legislature may authorize this to be done by any appropriate means which it may think expedient. As a question of constitutional power, the right to authorize cities and towns to buy gas and electricity for their use, cannot in the opinion of the Court be distinguished from the right to authorize the manufacture of it for their use. The first question was therefore answered in the affirmative.

The second question was one of more difficulty, owing to the difficulty of defining with entire accuracy all the characteristics which distinguish a public service and a public use from service and uses which are private. But the same conclusion was reached. The Court did not consider whether the furnishing of gas and electricity for supplying heat and power can be regarded as a public service, and expressly they did not pass upon that question.

This opinion of the justices having been received, the bill was taken up by the House and passed, though in a somewhat different form from that submitted to the Court. It permits any of the cities or towns of Massachusetts, not only to establish plants by purchase or otherwise, for municipal purposes, but to supply light, heat and power by means of gas or electricity to any of their inhabitants. It also permits any city or town thus establishing a plant to supply gas or electricity, for any or all of the purposes named, to adjoining cities and towns and to the inhabitants there. It contains no provision requiring the purchase by cities or towns establishing municipal plants, of plants already existing in such places, and permits the purchase of only that portion of existing plants that consist of "real estate or is attached to real estate so that it cannot be removed and rendered available elsewhere without material loss, injury or expense." In case of companies supplying both gas and electricity, the bill permits the purchase of one or the other branch of the business as the town or cities may elect. Notwithstanding the failure of this bill to become a law, the town of Peabody voted to establish a town plant for lighting its public street and incidentally to utilize its surplus power and apparatus in supplying private consumers. A bill in equity was brought to restrain the town from carrying this vote into effect. The case has been decided by the full bench of the Supreme Judicial Court, and will be recorded under the name of Spaulding vs. Peabody in vol. 151 Mass. Reports.

In deciding this case, the Court said "that the authority claimed for the town is not within any of the customary powers which towns from very early times have exercised, and must be derived, if it exists, from the statutes relating to towns." The authority was claimed under the provisions of a statute which employs language first used in an act of 1892—that a town may grant "money for all other necessary charges, arising in such town," and from the authority of towns to erect and maintain street lamps. But the Court pointed out that the phrase "all other necessary charges," has always been given a very limited scope, and that special enabling provisions have been deemed necessary whenever extensions of the courtesies of town expenditures have been sought. As to the claim that the power was incident to that of erecting and maintaining street lamps, the Court said: "The subject of construction and maintaining gas or electric works for the manufacture of gas or electricity, and the distribution of them through the streets of towns and cities, for the purpose of furnishing light, is one of too much importance to be attached as a mere incident to the power given to erect and maintain street lamps, and we think that if the legislature had intended that towns generally should have authority to erect and maintain such works, the authority would have been plainly expressed in statutes, with such limitations and accompanied by such restrictions as the legislature might think it prudent to establish. We see no indication in the existing statutes that the legislature intended to make provision for the exercise of such authority by the towns of the commonwealth." In order to leave no doubt upon the question whether towns and cities can, under existing laws, establish and maintain plants for municipal purposes only, some of the opinions concluded as follows: "If we assume that the only action now contemplated by the town of Peabody is the erection and maintenance of electrical works for the purpose of lighting its streets, still we are of opinion that the vote is beyond the legal rights and power of the town. P. S. Ch. 28 Sec. 129."

This decision upon the existing state of the law in Massachusetts as well as the opinion of the justices upon the constitutional questions involved, are herein stated with some particularity-owing to the importance of the questions and the eminent authority of the Court which has passed upon them. While both opinions rest largely upon the particular language employed, in the one case in our Constitution, and in the other case, in our laws governing towns, they involve the consideration of such important general principles that they are worthy of study in any jurisdiction.

In connection with the bill for municipal ownership, the committee on manufacture has before it the recommendation of the Governor, that the powers of municipal corporations be enlarged by general laws in the matter of "municipal control of municipal work and ownership of the instrumentalities for its performance,"—which it will be observed does not go to the extent of recommending the enlargement of the powers of towns and cities so as to enable them to manufacture and supply gas or electricity for commercial purposes. The Governor is on record against an extension of the law in the latter directions. In addition to the bill above referred to and the recommendation of the Governor, there are orders covering the same subject matter and numerous petitions in aid thereof; including a petition to the common council of the city of Boston. The extent to which some of the petitions go, is shown by the fact that in one case the passage of a law is prayed for, to enable cities and towns to engage in all lawful business that the citizens of such cities and towns may desire to enter into. Another one prays for a state loan of $3,000,000 to cities and towns, to enable them to build for the people, similar to state loans to railroad corporations. Separate petitions have been filed by the towns of Danvers, Peabody and Hudson, and the towns of Brookline and Melrose have voted to appear in favor of the general legislation.

Mr. Burdett then enumerated a number of measures now in committee, proposing to touch electrical interests in various ways. He then said:

"The foregoing statement includes, in outline, all matter of legislation and adjudication, with one exception, touching electric lighting interests which have arisen in Massachusetts since the last report. The exception referred to is the decision of the Supreme Court in the case of Suburban Light and Power Company vs. The Aldermen of the City of Boston, reported in Vol. 150 Mass., Reps. In this case it is decided that the granting of pole locations to electric light companies is not mandatory under our statutes (P. S. Ch. 109 Sections 2 and 3) upon aldermen or selectmen, but rests entirely within the discretion of those officials."

MR. FRANCISCO:—Speaking for the State of Vermont, I would say that we have not had very much trouble. The only case we have in my own town, Rutland, was about a year ago, in regard to municipal ownership. The aldermen conceived the idea that they could furnish electric lights without any expense to the citizens. They became convinced that that could be carried out through the influence of outside parties, and the wonderful stories told by different people; but by concerted action we had the matter referred to the popular vote, letting the masses vote upon the subject, as they did in the regular election, and the result was that the vote cast was 10 to 1 in opposition to municipal ownership, which eventually ended all strife on that question in that town for all time to come, I think. In the Legislature we had a bill introduced allowing one company to occupy the poles of another company, and that bill was killed in the committee room. We also had a bill introduced, which became a law, compelling all companies to remove all crooked poles, or poles that were not first-class in every respect, and replace them with new straight and perfect poles, and paint all poles within the city limit. We had a bill introduced at the last session requiring all electric light companies in running their lines to run the lines entirely distinct and in such a manner as not to interfere with the business or the wires or occupation of the telephone companies. That bill died a natural death in the committee room. There was also a bill introduced at the same time requiring telephone companies to comply with the same law and not run anything but metallic circuits with proper insulation. When that came up the telephone companies where anxious to have it die, and that died also in committee room.

Mr. George R. Stetzel, of New Bedford.—I should like to inquire if there has ever been a case where an electric light company had asserted any right to any property in the street in the use and transaction of their business? I represent a company in the State of Massachusetts, and, as I understand it, and as we act, we are very much in the position of the popular interpretation of the Dred-Scott decision. We have no rights that the white man is bound to respect; the city does as it sees fit in every instance, and we don't know of any method of redress. Out of perhaps eight hundred poles there are from eighty to one hundred that are used for any purpose that the municipality may see fit to put them to. Within the past three months the city has been establishing a police signal system; they have put their boxes on our poles, sawing some of the poles two inches needlessly, and it looks to me maliciously, that they may have a base for the box to rest on the pole. They have not only done that, but they have taken the wires from the top of the poles down through the boxes through an iron gas pipe, and from that box they go directly into the ground. My linemen say it will be a difficult thing to sit on the top of that pole in damp weather when, if any trouble should arise, I might order them to go to the top of the pole to rectify it. While I have filed a protest with the City Government and a notice that I shall hold them responsible for any damage to my workmen or to citizens, there has been no action taken as regards remedying their gross imposition on our rights, if we have got any. It seems to me that we should not only act a little on the defensive, but that in this matter if we have any rights we should assert them. I do not know that we have any rights, but it certainly is very disagreeable to a manager to have the best property which he has, confiscated in this way without any knowledge or consent of it on his part. The first I knew of the establishment of this police signal business by the city was that they were established and they were there.

Mr. Burdett:—And I wish to correct some of the ideas which Mr. Stetzel erroneously holds. If he has been advised that he has no right to the exclusive use of his poles, he has been incorrectly advised. There is a very great doubt as to the right of the city to interfere with a pole which has once been set, except to change its location. Now, as to the aggressive attitude which he speaks about, I would say that the difficulty with the gentleman is that he has not attended to these things at the State House in Boston. I never saw his face until this afternoon.

Mr. Stetzel:—I am new in the business.

Mr. Burdett:—Your company, according to my recollection, is not a member of our organization, who are fighting these things. If it had been you would have been kept informed of what was going on. However, sir, I shall be very glad to see you in Boston at our meeting to-morrow when we shall attempt to inaugurate something in the way of aggressive action. As a matter of fact, the electric light association, which I have had the honor to represent, have been fighting for their lives, and not fighting for the other fellows, and that has got to go on until we have strangled this insane agitation, and then we can turn upon them with something in the nature of an aggressive warfare. The position before the committee to-morrow is to take away the rights which I say now exists. It arises out of the petition of the mayor of Salem to be permitted to have all boards of aldermen and selectmen given authority to revoke absolutely every pole location in a city or town without any reference to prior grants which have been acquired. There is only one way of fighting it, and that is for all the companies to come together. The telephone companies and the street railway companies have joined us, and have all combined, and we propose to stand up for the rights which we now have. I say this to the gentleman, that he has rights with his poles in the street, and he should join us and help to maintain them; and I shall be glad to see him in Boston. A gentleman sits here at my right who represents a company from the eastern part of the State, who can testify that his particular company was saved from competition with a company which would have run him out of the town in spite of all he could do in protection of his rights, because they proposed to use a water power which up to that time had not been used. (Applause.)

Mr. De Camp. (In the chair.)—I would say that in the State of Pennsylvania the municipal authorities recognize the rights of the companies to their poles when they have once become established. I don't know that a company has ever been interfered with. The city of Philadelphia makes a respectful application to us for the right to use our poles as we do to them for the right to use theirs. Some five years ago when the question of removal of poles was up before the Legislature the very eminent counsel who argued the case there took the position, which did not seem to be questioned, that in case such a law was passed, which would mean the destruction of a vast amount of property for the use of which it was erected, the companies would be entitled to compensation. That, of course, has never come to an issue, but there seemed to be no two opinions about it.

On motion, the Convention then adjourned until Thursday, February 19th, at 10 a.m.

FIFTH SESSION, THURSDAY MORNING, FEBRUARY 19.

The session was opened by the reading of a paper on "The Ferranti System," by **Mr. C. D. Haskins**.[1]

In reply to a question by **Mr. M. D. Law**, as to the method employed by Mr. Ferranti, in making connection with the primaries of his transformer, Mr. Haskins said that four or five methods were in use for connecting on to the concentric mains. The commonest one was a good deal like the branch that a plumber would put into a pipe. The inner tube is brought through a sort of T-joint and carried a good distance before the insulation is removed from it. That gives one leg of the circuit. The other is taken off by an outside ring which is soldered on to the other conductor and goes in the other direction for a safe distance, covered by insulation.

Mr. Ferranti as a rule made his connections with current cut off the circuit, and did not attempt to handle the 2,500 volt wires when they are alive. Where it is found necessary to connect on when the circuit is alive, the double plug fuse is taken out on the primary, as this fuse can be put in with safety when the current is alive.

Mr. J. A. Seely described the method of connection employed by the Manhattan Electric Light Company, of New York City,[2] where they place the primaries in front of their houses and lead to insulated binding posts. In case a subscriber is put in they put in what they call a primary switch, and after the insulation is made and the lamps installed all that is necessary is to close a switch. They also interposed those switches into all their lines now, as the fire underwriters had requested it.

Mr. R. W. Pope then moved the adoption of the following resolutions:

> *Resolved*, That the sincere thanks of the National Electric Light Association be, and the same are hereby tendered, to the publishers and staff of the Providence *Journal*, the Providence *Bulletin* and the Providence *Evening Telegram*, for their very complete and accurate reports of the proceedings of this Convention which have appeared during our sessions in this city.

(Applause).

The resolutions were seconded and unanimously adopted.

Mr. F. A. C. Perrine refering to the rope gearing used by Mr. Ferranti mentioned that there was a very excellent system of rope gearing in use in the Providence Cable Railway power house, manilla rope being used.

Mr. T. Carpenter Smith then read a paper on "The Distribution and Care of Alternating Currents.[3]

In the discussion of Mr. Smith's paper, **Mr. M. D. Law** said that one of the principal causes of bad service, specially in the use of alternating currents, was in poor line construction. Another mistake was made in running lines where other wires are used than those of alterating currents, and in placing the alternating wire on the top; these should be kept down low, as there was not the danger to dynamos from the crossing of wires, as a cross on a direct current wire does not, as a rule, mean any damage to the apparatus. But in the case of a cross on alternating wires it means a burned out armature, unless insulations are especially good, and the circuit is fused very close to its maximum load. He finds this a very important point to look after. He advised the examination of all fuses carefully every day, and never to have the circuits fused to more than ten amperes above record of the daily run.

Mr. Smith had spoken of the necessity of carefully fusing the primaries of the converters. When Mr. Law took hold of the Denver Company he found that in a large proportion of their converters the primary fuses had been taken out, and No. 14 copper wire substituted. In the case of a burn-out in the converter, it would under these conditions mean a burned-out armature. If one had any number of dynamos the ampere load of each circuit should be kept within the smallest unit of the machines. This means the ability to make rapid changes in times of trouble without danger of overloading them.

A great mistake was made in putting the switch-board too close to the wall; especially when the fuses were put on the back of the board, and the board should be so arranged that a man can get out at any time, as it is sometimes rather a hot place, and not a good location to get penned up in. Each and every circuit should be provided with both volt and ammeters as Mr. Smith had stated. And in addition to this it was a good thing to arrange a many-point switch that could, at will, connect a standard Cardew or other voltmeter to any circuit; in fact, this could be done several times a day as the voltmeters in constant use were liable to get out of calibration. This was especially useful if one was placed in the position in which Mr. Law was, where the directors refused to get the copper, which was necessary to even up the loss on lines, and with thirty per cent. loss on one line and only two per cent. on another. In this case the extra voltmeter was absolutely required.

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[1] See page 237.

[2] For a full, illustrated description see The Electrical Engineer, July 2d, 1890.

[3] See page 211.

Great care should be taken that the exciter wires when they lead from bus bars are amply large, so that there may be no loss between exciter and alternator, or it may require such a high voltage in the exciter circuit that it may be dangerous to the dynamos where such wires are carried under the floor and the floor or the ground do not allow the use of an ordinary wire covered with soft rubber tubing; it is very dangerous from the fact that the oil which gets on them softens the rubber. A better plan is to make a small conduit or trough and thoroughly bed and cover the wires in plaster of paris; this is a good insulator and will prevent the entrance of oil or allow fire to follow the wire. Another important point in the construction of lines is where the primary loops are led off from the main feeder; as a rule, these wires are half spliced on to the main feeder and carried directly to the converter. This should always be done at the pole and such wires so arranged that it is impossible for a cross to occur where the primary wire crosses that of the main feeder; this Mr. Law finds to be a common fault, and in several instances, to his knowledge, has resulted in a No. 6 wire burning entirely through a number 0 wire and dropping the live wire in the street. Great care should be taken that this wire is carefully fastened at the pole in such a position that it will be impossible for a cross to occur.

Mr. A. F. Mason referred to the practice in Great Britain, where converters, contrary to the practice here, were not permitted to be placed outside of buildings. The one exception was the city of Philadelphia, where converters were permitted inside.

Mr. Haskins stated that no trouble whatever had been experienced in England with converters on the inside of buildings.

The President quoted Capt. Wm. Brophy as saying that there was no reason why the converter should not be put in buildings and yet he forbade it in Providence, and his only reason was that with the converter working warm, some of the insulation might smoke a little bit, and some one might cry fire, pull the fire alarm, and call out the department. His company had lost one converter only in the hundreds in operation in Providence, and that one was mechanically defective.

Mr. Smith, in answer to a query of Mr. Mason, said he had been accustomed for some years to regard slate as the best material as a backing for switch-boards, but within a short time he had had an annoying accident happen from the use of slate, owing to the presence of mineral in the slate itself. He had come across a statement that marble should not be used on account of the presence in it of so many veins of mineral, and that slate was the only good material, but he found that the pure white Italian marble could be had in blocks without any mineral in it whatever, and it seemed to him as though that would be the only substance that could be thoroughly depended on, though, of course, quite expensive. For that reason he somewhat favored putting all switches and cut-outs and work of that kind on marble or porcelain bases, but making the switch-board itself of wood, and allowing no wires to be clamped directly to it, and keeping everything off the switch-board two or three inches. An air space of three or four inches protects the board pretty thoroughly against fire. With a board of that kind, if there were danger of catching fire, he would not hesitate to turn the hose on it.

Mr. Smith also advocated an insulation which would not carry fire even though it were not absolutely waterproof, since the switch-board is generally in the driest part of the station.

Mr. Mason drew attention to the fact that any kind of cotton covering when soaked in a solution of tungstate of soda is rendered absolutely incombustible, and he suggested its use in central station work.

Messrs. De Camp, Armstrong and Francisco spoke in terms of high praise of Mr. Smith's excellent paper, and, on motion of Mr. De Camp, the paper was ordered to be printed separately for distribution among the members, and its full discussion postponed until the next meeting. It was also decided to print the discussion of the paper prepared by Mr. M. D. Law at the same time.

Mr. M. J. Francisco paid a high compliment to President Perry on his administration of the Narragansett Electric Light Co., of Providence, which had given that city a central station and a system of electric circuits which were models of their kind.

Mr. S. E. Barton, being called on by the President to state the objection of the underwriters to placing the converters inside of public buildings, said that there was no particular objection. The objection that took in the beginning in New England was perhaps primarily because it was a new thing, and because it was perhaps considered on the safe side to have converters on the outside; they never thought there was any danger from fire in putting converters on the inside of a building. He agreed that the construction of converters to-day was very much superior to what it was in the beginning, and he thought the time had come, perhaps, when it would be better, for many reasons, to put converters in a good, suitable location inside of buildings, and not outside. But he believed it was a wise decision that was made in the beginning, to exclude them from the inside of buildings.

Mr. T. C. Smith drew attention to the fact that much damage had been done to electric lighting interests in this country by the bad construction work existing in New York, and the accidents which had resulted therefrom, and instanced a case in point.

Mr. F. A. C. Perrine then read a paper on "Mutual Insurance of Accounts."[1]

In the discussion which followed the reading of Mr. Perrine's paper, Mr. De Camp said he was very much struck by the suggestions made; they were entirely new, and he felt safe in assuming that the author never had to manipulate the finances of an electric light station. It seemed to him that the arguments did not apply directly to the stations. He did not take it to be the province of the Association to insure against an insufficiency of capital in any business, which was one of the main causes of failure. The second cause of failure of the lighting companies had been due to their income not being sufficient to meet their expenses. That he did not think any Association wanted to put itself in a position to insure.

The competition among the manufacturers of material, had led them to go beyond the bounds of good judgment in extending their credits. In other words, the time came when there was a settling day and settlements had not been had, certainly, in a satisfactory way. There was no mode of insurance that could protect any community against such business methods. (Applause.)

Mr. Perrine referred to the fact that his firm, Messrs. Roebling's Sons' Co., had lost only $1,200 during the past year in a business amounting to over $1,000,000. That proved to him very clearly that the electric light companies were on a firm basis and that they are not companies that, as a rule, one would risk much in trusting. But he had seen cases—more when he was with an electric light company than now—when some of the best business of the company had to be lost; when it was necessary to allow ruinous competition to come into a town, because the stockholders, in spite of the payment of good dividends, and the extensions made out of the earnings, refused to allow any more money to make any more extensions, whereas the business was well worth borrowing the money on to make these extensions. That was practically the idea that Mr. Perrine had; a mutual insurance company of this kind was practically a mutual bank where one would have, not six per cent. for one's money, as fixed by law, but the actual cost of furnishing what was wanted, which is very much below that figure.

Mr. A. J. DeCamp then read the Report of the Committee on Data [2]

The President, as chairman of the Committee on the World's Columbian Exposition, reported that he had notified Director General Davis, of Chicago, of the appointment of the Committee, and of its willingness to co-operate with him in a way to secure the success of the exhibits. He had received a reply that the invitation had been received and placed on file, and at the proper time would be answered by the proper person. The Committee was continued.

The Convention then adjourned until 4 P. M.

AFTERNOON SESSION.

The Convention was called to order and immediately went into Committee of the Whole. On rising, the following officers were elected for the ensuing term:

President: C. R. Huntley, Buffalo, N. Y.; *First Vice-President:* James I. Ayer, St. Louis, Mo.; *Second Vice-President:* M. J. Francisco, Rutland, Vt.

EXECUTIVE COMMITTEE:

Class 1.—E. F. Peck, Brooklyn, N. Y.; John A. Seely, N. Y. City; R. Faben, Jr., Toledo.

Class 2.—Albert J. Corriveau, Montreal; H. H. Fairbanks, Worcester, Mass.; A. J. DeCamp, Philadelphia.

Class 3.—J. J. Burleigh, Camden; A. N. Robinson, Minneapolis; E. W. Rollins, Denver.

The recommendation of the Committee of the Whole that the next meeting be held in Montreal, in the month of August, was adopted, the Executive Committee to arrange the date.

The following resolution, offered by Mr. Shaw, was adopted:

> *Resolved:* That within thirty days of his election, the incoming President shall appoint a Committee of three active members of the Association, whose duty it shall be to formulate such amendments to the constitution as may be deemed necessary, and to submit their report at the next semi-annual meeting of the Association; the amendments thus reported to be introduced at the semi-annual meeting, and lie over under the rules, and be considered at the next annual meeting of this Association.

The Chair announced the following committee on "Standard Methods of Wiring:" Messrs. DeCamp, Barton, Brophy, Law and Smith.

The report of the Committee on Incandescent Lamps was accepted and the Committee discharged with thanks.

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[1] See page 235.

[2] See page 245.

The Committee on Legislation was continued.

It was agreed, on motion of Dr. Mason, that a committee of three on underground conduits and conductors be appointed to report at the next meeting.

Mr. Huntley, speaking on the subject referred to him at the last meeting, "How Can the National Electric Light Association Best Serve Central Station Interests," recommended that the advisability of having but one meeting a year be considered. He was not prepared to say that the time had arrived yet for that change, but he believed that it would soon come.

The President then introduced **Mr. Edward Weston**, who delivered a short address on "Electrical Measuring Instruments and their Methods of Use and Care."[1]

Mr. Weston was, by a rising vote, elected to honorary membership in the Association.

The President expressed his warm gratitude for the uniform courtesy and aid extended to him by the members of the Association and the Convention then adjourned *sine die*.

PRESIDENT PERRY'S RECEPTION.

The reception tendered the delegates on Wednesday evening, at Spink's Hall, by President Perry, will long be remembered as an occasion of the most perfect enjoyment by all present. It was an unqualified success from first to last.

The attendance was very large, the music and appointments of the best and the collation and vintage exquisite. The reception lasted from 8 o'clock to 11:30, and the music was furnished by the Hungarian Band from the Eden Musee, New York. The decorations were remarkably tasteful, the balcony being draped with smilax and the pillars adorned with clusters of roses and pinks. The chandeliers were decked with floral globes and bells.

The sight presented by the brilliant assemblage gathered together in the dancing and reception rooms was a beautiful and picturesque one and the galaxy of beauty was a stirring sight. President Perry made a prince of hosts and an evening of unsurpassed pleasure was spent by all.

THE RECEPTION AT THE AMERICAN ELECTRICAL WORKS.

The climax of the Convention festivities was reached in the complimentary reception Thursday evening by President Eugene F. Phillips of the American Electrical Works, at his factory on Stewart street. Owing to the increasing volume of business since the establishment of the concern, it has been found necessary to build a large addition to the five story structure, two floors of which were transformed into a brilliant hall for the guests.

The ball room covered an uninterrupted space of 146x60 feet, and much care had been taken in trimming the walls and ceiling in an artistic and attractive manner. The walls for the entire circuit were trimmed with flags wrought into butterflies, festoons and other picturesque designs, with Japanese parasols, shields and emblems set at frequent intervals. The stage occupied by the musicians was flanked by tropical plants and ferns in dense profusion. In the window recesses were set choice plants, orchids and other rare products of the conservatory. The shafting and pulleys on the ceiling were concealed beneath a drapery of bunting and violet globes depended from the spaces where the larger pulleys were hung. The hall was brilliantly lighted by hundreds of incandescent lamps, and the floor was highly polished for the dancers. Several apartments were reserved for the ladies and gentlemen as toilet, smoking and cloak rooms, and the floors leading to the ball and supper rooms were carpeted, for the protection of the ladies' costumes.

The grand march was begun at 9 o'clock, and at that time there were a company of over 400 guests, including Gov. Davis, ex-Mayors Hayward and Barker, President Perry, President Watson of the Common Council, Aldermen Winship and Fuller, Gardiner C. Sims, Hon. William A. Harris, Gen. C. H. Barney, and a number of others prominent in socal, professional and business circles. Then followed a long series of dances, in which fashionable figures predominated.

There was an intermission at midnight, and to the music of the orchestra, the company ascended to the supper hall where Gelb & Norton provided a choice collation. The dance favor was unique in design and workmanship, the covers being of drab chamois, decorated with an engraving of the works, the menu and list of committees and plan management. The reception committee was: Messrs. Marsden J. Perry, W. H. Sawyer, C. H. Barney, Allen R. Foote, E. A. Maher, A. J. De Camp, H. B. Cram, Charles W. Price, C. D. Haskins, S. A. Duncan, M. A. Knapp, C. R. Huntley, F. W. Webster, M. T. Pulsifer, C. L. Edgar, E. F. Peck, F. A. Gilbert, B. F. Hamilton, R. F. Ross, A. M. Young, H. H. Fairbanks, George C. Roe, A. D. Newton, E. D. Floyd and H. L. Luflin. The floor director was Mr. William A. Hathaway, and his aids were Messrs. P. C. Akerman, C. R. Remington, John Carroll, Lincoln V. Davis, E. Rowland Phillips, C. H. Wagenseil, Albert L. Capper, George H. Heathcote, H. A. Barker and Frank N. Phillips. The ball came to a successful termination at 2 o'clock, and the delegates retired enthusiastic in the opinion that Messrs. Phillips and Sawyer and their associates had once more exhibited perfect taste and tact as hosts and "entertainers by appointment to the electrical fraternity."

EXHIBITS.

Washburn & Moen Manufacturing Co., of Worcester, Mass., exhibited a very handsome case containing samples of all kinds of bare iron and copper wire from No. 40 gauge up to heavy stranded cables.

Sandford Electric Protector Co., of New York, exhibited a few samples of their protector which is claimed to be an absolute protection against lightning and all danger from excessive currents in telephone, fire alarm, and other low tension circuits.

Charles A. Schieren & Co., of New York, exhibited a number of samples of their favorite perforated belting, specially adapted to dynamo driving. They did not show any large belts, but showed a photograph of a battery of belts recently shipped for electrical purposes, the largest one being the 72-inch double belt for the Louisiana Electric Light Company, New Orleans, La. Messrs. C. A. Schieren, Jr., Mr. E. P. Atkinson and Mr. G. H. Hamblett were in attendance.

Russell Electric Lamp Co. showed two of their new disc carbon arc lamps, which are constructed with a view to burning for a long time without removing the carbons. Their ordinary 24-hour lamp and their more recent 10-hour "Baby" lamp for store purposes, were both shown in operation and attracted a great deal of favorable comment.

The Ellis Oil Filter Co. exhibited one of their special filters for central stations for filtering the oils after usage, so that they can be used over again.

The National Pipe Bending Co., of New Haven, Conn., manufacturers of the National Feed Water Heater, were represented by Col. S. J. Fox.

The Evans Friction Cone Co., of Boston, were represented by Mr. G. F. Evans the inventor of their frictional system of driving dynamos.

Steele & Johnson Manufacturing Co., of Waterbury, Conn., were represented by Mr. Albert H. Mills, who carried around with him for the inspection of his friends a select lot of samples of brass goods for electrical purposes.

The Simplex Electrical Co. exhibited a few sample reels of the famous "Simplex" wire, and were represented at the Convention by the ever popular Dr. A. F. Mason, and Mr. A. F. Talcott.

The Buckeye Electric Co., of Cleveland, O., were represented by their Eastern representative, Mr. Louis R. Wallis, who showed samples of incandescent lamps of all voltages and candle powers.

"The Western Electrician," occupied parlor No. 2 and was represented by Mr. W. A. Kreidler, John B. O'Hara, W. H. Temple and C. M. G. Paine. Mr. Kreidler had in his current issue achieved the unique distinction of carrying six pages from one advertiser.

Henry F. Jenks, of Pawtucket, R. I., exhibited one of his new improved drilling and tapping machines, which is specially adapted to the manufacture of electrical goods.

The Washington Electric Conduit Co., of Washington, D. C., exhibited samples of their glazed terra-cotta conduit, which has been extensively used for telephone and electric light purposes.

H. W. Johns Manufacturing Co., of New York, were represented by Mr. J. R. Burdick, who has been recently appointed to take charge of their Vulcabeston department, and all applications of their material for electrical purposes.

The Union Electric Manufacturing Co, Bridgeport, Conn., were represented by Mr. John M. Orford, who distributed a number of small cards printed on which were a number of strong claims, pertinently put, for the new switch, a sample of which Mr. Orford showed, though he carefully avoided showing the working parts. It is predicted that this switch will yet revolutionize the switch business, and if it accomplishes all that is claimed for it on the card mentioned above, there should be a large demand for it amongst the live members of the electrical fraternity.

The Clark Electric Co., of 192 Broadway, issued a very tasteful card, presenting in relief a view of one of the company's arc lamps mounted in an ornamental chandelier for interior lighting. Their fixtures are artistic in design and handsome in finish. A very valuable feature of the Clark lamp is that it can be operated from either arc or incandescent circuit. This gives them a wide application, as the running of arc lamps on incandescent circuits is deservedly becoming very popular.

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[1] See page 244.

The Electric Merchandise Co., of Chicago, made a handsome exhibit in parlor 1 of their raw hide pinions, now so well and widely known as a *sine qua non* for street railways. They were ably represented by W. R. Mason, general manager of the company, and his versatile assistant, Mr. D. B. Dean, traveling representative.

The Insulite Mfg. Co., of New York, represented by Mr. Thos. Roebuck, showed their new "Insulite socket." The simplicity with which this socket is wired, and its positive insulation, particularly recommend it.

Mr. E. L. Powers, proprietor of our esteemed contemporary, *Electrical Industries*, Chicago, looked after the interest of his paper in a very thorough manner, and was assisted by Mr. E. E. Wood.

"The Electrical Review," of New York, was well represented by its staff as follows: Mr. Chas. W. Price, Mr. S. L. Coles, Mr. H. T. Richard, Mr. W. I. Barker, of Boston, and Mr. Geo. C. Maynard,, of Washington.

The American Electrical Works, Providence, had their headquarters in parlor 10, where every delegate was made welcome and presented with a box of candy. Upon opening this, however, and when about to enjoy the dainty caramel, he found himself met with a toughness as of their insulation, which prevented him luckily from swallowing the sermon contained inside. They also made a handsome exhibit in Union Hall. They were represented by Mr. Eugene F. Phillips, president; Mr. W. H. Sawyer, secretary; Mr. W. A. Hathaway, Mr. P. C. Ackerman, N. Y. agent, and Mr. John Carroll, secretary and treasurer of the Canadian company.

Mr. Myron A. Knapp, of the Knapp Electrical Works, Chicago, was out in force, and as usual surrounded by a host of friends.

The Electrical Supply Co., of Chicago, were represented at the meeting by Mr. Franklin S. Terry, manager, and Mr. Chas. Wirt, who displayed their new specialties and looked after everybody in their usual accomplished manner.

The American Oil Co., of Providence, exhibited samples of their dynamo, cylinder, and engine oil. Mr. J. C. Davis, treasurer, is looking after the interests of the company.

Mr. C. S. Van Nuis, perhaps better known by the classic name of "Ajax," made a handsome display of his Ajax switches and also the new lightning arrester, which, from personal observation, we may describe as a dazzling success.

Mr. L. E. Razee, of Boston, who deals largely in electrical supplies, was on hand.

Alexander, Barney & Chapin made a most comprehensive exhibit of their lines of supplies and new specialties. Their historic exhibit attracted the attention and commendation of all.

The E. S. Greeley Co., of New York, exhibited their high grade testing instruments, steam and electric railway and light supplies. Mr. F. A. Magee was on deck as usual looking after their interests, and Mr. Chas. P. Frey, their electrician, was with him.

The New York Insulated Wire Co. exhibited their well-known Grimshaw wires and cables. J. W. Godfrey, the manager, was on the ground looking after the "Nation's Choice."

The Crescent Insulated Wire and Cable Co., of Trenton, N. J., were represented by Mr. C. Edward Murray, president, and Mr. Thos. D. Reed, manager. They are making a new insulation having a process and special machinery for weaving a glass insulation on to the copper.

The Bryant Electric Co. had a handsome exhibit of their well-known switches and sockets.

Mr. George Cutter, of Chicago, the "electrical specialist" of the West, was right there, and had a most attractive exhibit of numerous good things, among them shades, railway trolley hangers, pole tops, the new globe holders and self-supporting arc lamp pulleys, and last, but by no means least, some of those prolifically fetching and enticing dodgers, such as the sleeping bull frog, the outcome of Mr. Cutter's fertile genius.

The Forest City Electric Works, Geneva, O., exhibited a 1,000 ampere double pole jaw switch of special construction, which is known as the Cleveland Duplex. Mr. Cleveland was showing up the merits of his switches.

The Engineering and Equipment Co., New York, showed samples of their indurated fibre pipe for conduits, which has been extensively used for this purpose. Mr. C. H. Sewall represented the company, assisted by Mr. Perrine, of Brooklyn.

The Illinois Electric Material Co., with their new catalogue reached every one's heart, and Mr. Ernest L. Clark, the secretary of the company, was around, and showed samples of their supplies and specialties, which he described in his typically graphic manner.

The Eureka Tempered Copper Co., of North East, Pa., made a fine display of tempered copper for all kinds of purposes. Mr. A. L. Daniels, noted for his genial qualities, had charge of the exhibit, and was assisted by Mr. N. Bushnell. The tensile strength of tempered copper is stated as 84,689 pounds to the square inch as compared with 19,872 pounds to the square inch of ordinary copper.

Mr. L. E. Wilcox, of L. E. Wilcox & Co., New Haven, Conn., showed the new speed wire stricker, which attracted lots of attention.

The Safety Insulated Wire & Cable Co., represented by Mr. W. G. Sellers, general agent, and Mr. Requa, general manager, exhibited coils and samples of their "Safety" seamless wires and cables for inside and line work.

The Standard Paint Co. had a display of "P & B" in many of its applications. The fine insulating and preservative qualities are known everywhere. Ralph L. Shainwald, president, and F. S. De Ronde were on hand.

The Phœnix Glass Co., of New York, made an elegant exhibit of their globes and shades for electric lighting. Mr. E. H. Peck represented them ably.

The Thermal Electric Co., of Gloucester, Mass., showed their multiple thermal cut-out.

The Jenney Electric Motor Co., of Indianapolis, was represented by Mr. Chas. D. Jenney, whose work in the electrical field has been of long standing and of the best. He exhibited one 3 h. p. and one 1 h. p., 500 volt machine, and a ¾ h. p. 110 volt motor. Their excellent work and beautifully smooth running attracted many favorable comments.

The Sperry Electric Co., of Chicago, had a most attractive show, and were represented by Mr. C. E. Gregory. A triple carbon lamp, a single carbon lamp, and the Sperry regulators were shown in operation.

The National Electric Protector Co., of New York, showed the Sanford electrical protector; Mr. C. E. Sanford, the inventor, was in attendance. This protector is of inestimable value for protecting telegraph and telephone circuits from dangerous currents.

Claflin & Kimball, Boston, New England agents of the Mather system, had a fine exhibit, in connection with that of the Parker Lamp Co., of their incandescent apparatus.

Lieut. H. K. Gilman, Mgr. of the Great Western Electric Supply Co., Chicago, was present and made a host of friends among those who now had the pleasure of greeting him in the East.

Col. J. H. Shay, of the Chas. Munson Belting Co., was right there all the time, booking orders and answering electrical conundrums. His rawhide canes vanished like smoke, and the factory is now running night and day to execute Col. Shay's promises.

The New York Insulated Wire Co. was well represented by Messrs. Place, Godfrey and Meeker. The company, through Mr. J. W. Godfrey, Gen'l Mgr., will shortly offer the trade a complete system of wire ducts for interior wiring of buildings. These tubes, or ducts, are to be known as "Vulcanoid Electric Wire Ducts." The material is said to be non-inflammable, waterproof, a perfect non-conductor, not affected by extreme heat or cold, or plaster, and pliable and smooth as glass. The compound and tubes are the invention of Mr. Geo. H. Meeker, and the system is that of Mr. A. Noll, both of the company. The reputation of the company promises that the demand for the Vulcanoid electric wire ducts will fully equal that of the celebrated Grimshaw white core wires, for the company are noted for their persistency in pushing a good thing to success.

The National Electric Co., of Philadelphia, distributed the Warrell fuse block in miniature form.

Lewisohn Bros. were represented by Mr. Rosenstamm in the copper colored suit—somebody wanted to buy him for an ingot. Mr. L. Lewisohn was also present.

The Crocker-Wheeler Motor Co. made a remarkably handsome exhibit in operation of their motors, which on account of their beautiful design, both electrically and mechanically, were commented on by all. The perfection in detail in these machines is most striking. Dr. S. S. Wheeler and Mr. G. W. LaRue were in attendance.

The Clement Mfg. Co., Northampton, Mass., exhibited something first-class and highly novel in the shape of their rubber insulated screwdrivers and plier.

The Weston Electric Instrument Co., of Newark, were represented by Mr. Edward A. Colby. Their famous testing instruments are in universal demand.

The International Okonite Co., of New York and London, Eng., had a double exhibit of attractive style and magnitude. Capt. Willard L. Candee, George T. Manson, H. Durant Cheever and T. McCoubray were all on the spot, and had a good time all round.

The Shultz Belting Co., of St. Louis, were represented by Mr. J. A. J. Shultz, president, and exhibited their noted belting and new pulley covering.

The Johns-Pratt Co., Hartford, Conn., with their vulcabeston insulation, were distributing their paper weight souvenirs. Mr. Edward B. Hatch and Mr. E. B. Williams were present.

"The Electrical Engineer" occupied parlor 7, immediately adjoining the headquarters of the Executive Committee. Besides issuing every day its regular programme of the business before the Convention, the Engineer tried a novel experiment in the shape of a complete registry in its parlor, of all in attendance, the names being posted up on racks as quickly as the arrivals occurred, together with the number of the room occupied by each guest, and other brief information. The registry was in steady use by everybody as a ready reference throughout the Convention, and the stately urbanity presiding behind the Hotel desk characterized the new departure as "a perfect Godsend." The Engineer also had the gratification of publishing the largest electrical paper of the week, namely one of 100 pages and colored supplement. It received innumerable congratulations on the swiftness and sureness with which it had attained this position among a group of technical journals well known for their ability and enterprise.

"The Electrical World" made a bold bid for popularity by a big display and a "full page" style of hospitality. On Wednesday evening, it gave a very delightful and unconventontial "free and easy" in its parlor, with Mr. Johnston as master of the ceremonies, Mr. Fred Royce as guard of the exit, and Mr. Outcault as star raconteur "for this occasion only." The piano was also called into frequent requisition, and was tuned quite often by Mr. G. M. Phelps and other guests. The flow of wit and wine was without parellel at the Convention, and those who participated, could do little else when they met the next afternoon, but exchange languid recollections of an event that deserves place among the Noctes Ambrosianæ of the N. E. L. A. The *World* issued, as usual, its bulletin of the meeting, with wonted fullness and accuracy, due to the painstaking efforts of the indefatigable Caldwell and De Land.

"The Electrical Age" was well represented by its entire New York staff, and made *the* success of the Convention in the souvenir line with its "Aluminum Age" medal. The medal is a very neatly executed one, the size of a dollar ; and as they were bored and had a ribbon attached, everybody wore one. In fact, the good people of Providence got the idea that the medal was the Association badge and treated every wearer accordingly with due honors. It is also said that a great many were paid out as good current coin by waggish and festive "night owls," and were presented later on at the Hotel for redemption. Be this as it may, it is certain that a Convention souvenir was never more of an instantaneous and pleasing success than this, and that the *Electrical Age* deserves a gold medal for its enterprise and originality. The souvenir was moreover extremely appropriate, seeing that it is to progress in the electrical arts that aluminum now owes its position as a useful and readily obtainable metal.

"The Electrical Review" carried off the honors of the Convention floor by its prominence in the Memorial Exercises on Decennial Day. In the absence, through sickness, of Mr. Geo. Worthington, who had been invited to speak, Mr. C. W. Price, the editor of the paper, presented a very interesting historical sketch of the work done by the *Review* in starting the Association. Before the session closed, appropriate action was taken by the passage of a resolution of sympathy with Mr. Worthington in his illness, coupled with hopes for his early recovery and reappearance in active work. At the Hotel, the *Review* occupied one of the large parlors, and received its friends in accustomed manner.

"The "A. B. C." Pole Finder.—One of the hits of the Convention was the neat little book with this suggestive name, issued by Alexander, Barney & Chapin, as a souvenir. It contained a number of sheets of prepared paper for indicating the polarity of a current. The cover was a very pretty one in green and gold.

Thomson-Houston Electric Company exhibited a number of meters for various classes of work. A 1000 volt meter for going on the primary circuit of alternating current circuits was exhibited in operation, and a three-wire direct current meter was also shown working. In another part of the building, a 50 volt meter for secondary alternating circuits was shown, and a 500-volt direct current meter for use on electric railway circuits. A Thomson-Houston motor was also shown operating the exhibit of the New England Butt Company, of Providence.

American Circular Loom Co. showed a very interesting sample of a new flexible conduit for interior work. This conduit is composed of glass beads, surrounded by a strong woven covering, and possesses a number of advantages for interior conduit work. In the exhibit a large glass tube was shown bent in the form of a U and filled with water. The flexible conduit was then strung through the glass tube immersed in the water, and wires carrying current for lights mounted on the board, were inserted in the conduit. The lamps burned all right, showing the high insulating qualities of the conduit, as well as its peculiar adaptability for wiring the inside of houses, no tees, bends or joints of any kind being required. Mr. A. T. Clark represented the company at the Convention.

The Eddy Electric Manufacturing Co., of Windsor, Conn., exhibited two of their well-known 10 horse-power 500 volt motors, and also a ½ and a 1-horse power, 110 volt motor and a 75 light dynamo. The 10 h. p. motors were both used to drive dynamos, one furnishing power to a 100 light Loomis dynamo, and the other driving the 75 light dynamo, mentioned above. The exhibit was well taken care of by Messrs. A. D. Newton and M. E. Baird.

Drake, Payson & Whittier, of Providence, agents for the Eddy motor in Rhode Island, assisted the Eddy Manufacturing Company in showing the motors, and also exhibited the Loomis dynamo, of which they are also agents. A Loomis arc lamp was also shown in operation. They also exhibited two ordinary wooden lamp poles, with Russell mast arms, one showing the top mast arm, and the other showing the side mast arm. Samples of lamp hoods in several styles were also exhibited. Drake, Payson & Whittier are also agents in the East for the Hart snap switch, and the Loomis automatic ground detector. They were well represented by all three members of the firm.

The Jewell Belting Co., of Hartford, had quite an extensive exhibit of their dynamo belting made out of the centres of hides. These belts are becoming universally popular among central station men on account of their first rate qualities. The Jewell Company exhibited everything from the rough leather to the finished belt, and showed a very fine belt 40 inches wide, manufactured for the Toledo Electric Street Railway Company, of Toledo, O., as well as a number of smaller belts. The most interesting part of this exhibit, however, was a sample of a complete butt just as it comes from the tannery, showing a measurement of over five feet of good solid leather which could be used for the belting, and showing how very particular the Jewell Company are in the selection of extra heavy hides for the dynamo belts. The Jewell Company use only the centre of the hides for dynamo belts, no matter how narrow, and one of the best trade marks which they could use, is the mark of the spine of the ox, distinctly traceable down the centre of each belt, manufactured for dynamo purposes. The Jewell Company were ably represented by Messrs. C. E. Newton, C. L. Tolles, E. L. Graves and J. H. Fitzpatrick.

T. M. Foote Regulator Co., of Boston, exhibited one of their 4 horse power patent speed regulators, which attracted considerable attention. Owing to some misunderstanding the regulator was not shown in action, but the principles involved in the construction of the machine were well explained by the representative, with the assistance of several pieces of the mechanism before being put together.

The Holtzer-Cabot Electric Co., of Boston, exhibited only one novelty in operation, their new automatic regulator and pressure indicator.

Albert & J. M. Anderson, of Boston, exhibited samples of the Boston trolley, which is now almost universally used on electric cars, and also a complete line of trolley wire insulators, trolley wire clips, line wire insulators, strain insulators, and other necessaries. Mr. Anderson, himself, carefully explained the merits of his specialties.

The New England Butt Company, of Providence, showed three of their regular type of single and double braiders, and also showed their new machine for covering magnet wire, illustrated in The Electrical Engineer of February 18th. The machines were shown in operation, getting their power from a Thomson-Houston motor installed for the purpose.

The Electric Engineering and Supply Co., of Syracuse, N. Y., exhibited a fine switch-board, with variegated globes and arrangement of lamps, and a full line of wall sockets and Crowell switches for operating the lamps. Fine samples were also shown of station switches, double pole and double throw, E. S. rosettes, key sockets for all systems, fixture spurs, plain and clamp, fixture cut-outs and ceiling rosettes without fuses. They showed also an automatic clock for extinguishing incandescent lights at any predetermined time, and also a full line of specialties for line work, and electric railroad supplies. The exhibit was in charge of Messrs. F. H. Leonard, Jr., J. L. Hinds and Percy A. Clisdell.

The Munsie Coles Subway Co., of New York, were represented by Mr. Thos. L. Coles, Jr., who showed a number of drawings of his subway and interior conduit.

The Bernstein Electric Co. exhibited a number of their series incandescent lamps and fittings, and made a special exhibit of their new current and potential meters which can be used either on direct or alternating circuits. These instruments are absolutely accurate, have no iron or steel in their construction, and are portable, possessing very little weight. Though but recently introduced, the demand for them is already unprecedented. Mr. H. B. Cram and Mr. W. C. Fish, attended the Convention and looked after the exhibit.

The Standard Electric Co., of Vermont, were represented by Mr. F. M. Ferrin.

The Parker-Russell Mining & Manufacturing Co., St. Louis, the well-known manufacturers of "Sunlight" carbons were ably represented by Mr. D. R. Russell, who held his end up in the most approved fashion. Mr. Parker was also present.

Mr. Clarence E. Stump was present with his associate of the *Street Railway Journal*, Mr. J. H. McGraw, and was received by everybody with a welcome that would probably have carried a less modest and self-possessed man clean off his feet. While many who had not seen him since his release from an irksome and thankless task, expressed their regrets that he had to a certain extent ceased to be an electrical man, they did not fail to congratulate him heartily on his connection with so admirable a paper as the *Journal* and upon the fact that in most respects he was still "one of us." Mr. Stump had the pleasure of introducing Mr. J. H. McGraw all around, and between them the whole field of Convention work and acquaintance was well covered.

Mr. E. V. Cavell, though far from well, showed the growing reach of electric light and power interests by coming all the way from Chicago to represent the *Street Railway Gazette*. His enterprise had its reward.

The C. McIntire Company, of Newark, N. J., were represented by Mr. McIntire, who had a full line of samples of his invaluable connecters with him on exhibition.

Jas. W. Queen & Co., Philadelphia, had a most extensive exhibit of their well-known testing instruments of all kinds and were represented by Mr. E. G. Willyoung.

The Crosby Electric Co., New York, showed their batteries, which are noted for their many excellent qualities. Mr. L. Walsh was in charge.

The Perkins Electric Switch Mfg. Co. had a most comprehensive exhibit of their switches, lamps, etc., which attracted its full quota of attention. Mr. E. W. Davis looked after the company's interests.

The National Electric Manufacturing Co., of Eau Claire, Wis., exhibited their excellent alternating system and the Hon. Geo. B. Shaw, general manager, was on hand to explain its salient and advantageous features. Mr. Latshaw was also in attendance.

The Connecticut Motor Co., of Plantville, Conn., showed their machines in operation. Their many merits and beautiful mechanical workmanship called forth numerous tokens of commendation.

A. N. Baeder & Co., Providence, showed their new metallic cable support.

The Consolidated Fruit Jar Co., of New Brunswick, N. J., had their specialties, fuse wire, &c., on exhibition in charge of Mr. F. P. Wisner.

Pass & Seymour, of Syracuse, N. Y., exhibited a number of their specialties in China goods for electrical work, embracing circuit breakers, rosettes, cleats, bases for switches, sockets, etc. They claim that these China goods are much stronger than those of porcelain and not at all brittle, and screw threads can readily be moulded in the material. Mr. A. P. Seymour, who looked after the interests of his company, showed also his improved carbon holders for arc lamps.

H. T. Paiste, of Philadelphia, had a handsome board on exhibition with a large variety of his well-known switches bearing his name. Particular attention was given to these switches, made of material which is specially designed for use in rooms where something ornamental as well as useful is required, and some very beautiful colors and designs were displayed.

O. S. Platt, of Bridgeport, showed a complete line of his well-known switch, and attended to the inquiries of his numerous friends and patrons in person.

The Walker Electric Co., of New York, showed their new recording meter and ammeters in operation, and Mr. G. W. Walker explained the inside workings of the machines to hosts of enquirers.

The Standard Electric Supply Company, of Boston, showed a complete line of Platt switches and Hill switches, but made a special display of the Standard measuring instruments for which they are exclusive agents. They also showed a sample case of wires and cables manufactured by J. A. Roebling's Sons' Co., of Trenton, N. J. and samples of their screw drivers with insulated handles. Mr. W. A. Stowe officiated for the Standard Company in his usual engaging manner.

The Pettingell-Andrews Co., of Boston, the New England specialists in Okonite and "K. W." goods, made a handsome display of wires, cables, cut outs, rosettes, P. A. rosettes, and in fact showed samples of almost everything required in the electric light and railway business. A reflector for the headlight of a car, was one of their most novel exhibits. Mr. F. E. Pettingell, Mr. D. A. Andrews, Mr. C. W. Price and Mr. Levi Cofren represented them at the Convention.

Gould and Watson Co., of Boston, the well-known manufacturers of moulded mica specialties, exhibited a full line of electric railway insulators, and all kinds of appliances insulated with their material. They showed an incandescent lamp fitted on one of their new waterproof sockets burning in a glass jar of water, to prove their claims to waterproofness. A full line of screw drivers manufactured by the Clement Manufacturing Company, of Northampton, Mass., and insulated by moulded mica, was also shown. Mr. E. P. Sharpe, of Boston, was in charge of the exhibit, and Mr. C. Tennant Lee was also in occasional attendance.

The American Electric Works, of Providence, showed very beautifully finished samples of everything in the shape of insulated wire, from the finest grades of magnet and annunciator wire up to large lead covered telephone cables. Flexible cord was also in abundance, and the exhibit with the reels of line wire, surmounted by coils of variegated hue of office wire, made a very attractive appearance.

The Standard Underground Cable Co., of Pittsburgh, showed some very handsome samples of their well-known underground wires and cables, and wires for aerial use. They also had a number of their No. 11 handbook for distribution, on which there was a great run, it being a perfect mine of information to the Electrical Engineer. Mr. J. W. Marsh and Mr. T. F. O'Connor were in attendance.

The B. & S. Electric Equipment Co., represented by Mr. N. Bushnell, showed a few samples of the B. & S. special "roxite" ceiling cut-out, which is perfectly acid, water, and fire-proof.

A. W. Harris Oil Co., of Providence, showed a number of samples of their oils specially manufactured for engine, valve and dynamo use. Neat little sample cases of the oils were freely given away.

The exhibits, beyond those in the hotel, were grouped in Union Hall, where, under the able direction of Gen. C. H. Barney and Mr. W. J. Hammer, a large and beautiful display was made. The Exhibition was opened with electrical honors on Tuesday evening, by the young daughter of Supt. Thomas, of the Narragansett Electric Light Co., of Providence. The Exhibition was visited by thousands of persons.

THE NEW ELECTRIC MERCHANDISE CATALOGUE.

The Electric Merchandise Company, of Adams street, Chicago, have issued their mammoth new catalogue of electric railway supplies, to which line, as is well known, they devote their entire attention.

The book is most complete in every detail and will be found of the utmost utility to every street railway man, who should not fail to secure a copy immediately, and they will find it of unsurpassed value. It is very handsomely and uniquely gotten up throughout, being replete with handsome cuts and comprehensive descriptive matter of every article. Many new new specialties of striking novelty and advantage are embodied in it. Measuring and testing instruments, regulating station apparatus, lightning arresters, switches, incandescent lamps, sockets and fittings, cut-outs, fixtures and fuse wires, insulating material, headlights, gongs, electric heaters, poles, trolleys and trolley wire insulators, centre curve insulators, pull-over brackets, wire, line construction tools, and all the other detailed portions of apparatus which go to make up the complete electric street railway. The new Brewster trolley hanger is of special interest and will probably be known as the "Scissors" trolley hanger. It works on that old-time and highly effective principle. The catalogue is replete with many valuable points on construction work, and is one of the most complete, desirable and best ever brought out.

W. F. Wheeler, electrician for The Equitable Life Insurance Company, is still in St. Louis, fitting up the company's building in that place, with electric apparatus.

TRADE NOTES AND NOVELTIES

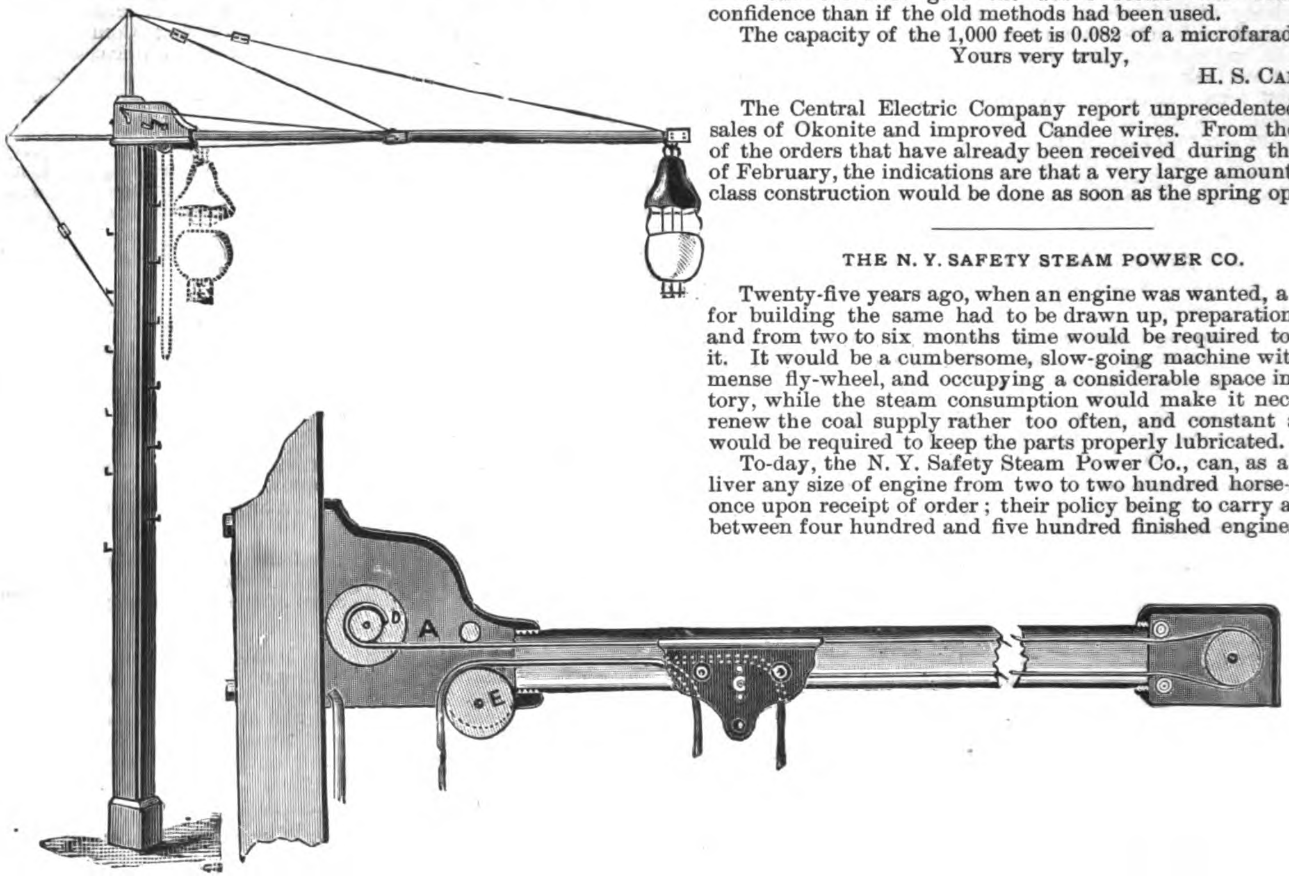
AND MECHANICAL DEPARTMENT.

"He who advertises boldly has faith in himself, in his goods and in the public."

THE RUSSELL MAST ARM.

THE accompanying illustrations, Figs. 1 and 2, represent a mast arm for suspending arc lamps over streets, public squares, etc., made by the Russell Electrical Manufacturing Company, of Providence, R. I. As will be seen, the arm is fixed, and the lamp is drawn to and from the pole by means of pulleys encased in a hollow cylinder. The arm may be attached to the top of the pole, as shown in Fig. 1, or to the side.

Fig. 2 is a lateral section of the arm, showing the carriage C the cord A and the drum D by means of which the lamp is drawn out over the street. The electric cable itself, passing over the drum E, is used to draw the lamp to the pole.



FIGS. 1 AND 2.—THE RUSSELL MAST ARM FOR SUSPENDING ARC LAMPS.

There are no visible electric wires, and all the mechanism is encased so as to be absolutely protected from snow and ice. The arms may be of any length, and by means of suspending cables, lamps may be carried into the centres of the largest public squares.

The longest arm now in use is 42 feet, and the shortest five feet. The main parts are made of extra heavy lap-weld steam pipe, the rods of either steel or the best Norway iron, and the working parts and fittings are all interchangeable, and are case hardened to prevent wear. The electric conductors are made especially for this arm by the American Electrical Works.

These arms are in use in 40 cities and towns throughout the country, and were favorably commented upon by the members of the National Electric Light Association at Providence.

THE CAMBRIDGE ACCUMULATOR is the property of the Cambridge Accumulator Company, of Boston, of which Mr. Matthew Clark is president, and Mr. Wm. A. Macleod is attorney, to whom all communications should be addressed at 62 Devonshire street, Boston, Mass. The cell is the invention of Mr. George E. Hatch, of Cambridge, Mass., who has been at work on it for about two years. It is fully covered by United States and foreign patents.

A TEST OF OKONITE.

The Central Electric Company has just received the following letter:

UNIVERSITY OF MICHIGAN, ANN ARBOR,
Feb. 12, 1891.

Physics aud Electrical Engineering.

MR. F. W. CUSHING,
Sec., Central Electric Co.,
Chicago, Ill.

Dear Sir: Some time in the latter part of 1887, the Central Electric Company sent me a coil of 1,000 ft. No. 18 B. W. G. braided Okonite wire, to be used in measuring insulation resistance. For more than six months of the time since, it has been under water in a tank. Its insulation resistance has increased, rather than the reverse.

At present, it measures 16,100 *megohms per mile* at a temperature of 17° C.

Mr. Patterson, instructor in physics in my laboratory, has devised a new and improved method of measurement, by which the percentage of error is much reduced.

I can therefore give the above result with much more confidence than if the old methods had been used.

The capacity of the 1,000 feet is 0.082 of a microfarad.

Yours very truly,
H. S. CARHART.

The Central Electric Company report unprecedentedly large sales of Okonite and improved Candee wires. From the nature of the orders that have already been received during the month of February, the indications are that a very large amount of high-class construction would be done as soon as the spring opens.

THE N. Y. SAFETY STEAM POWER CO.

Twenty-five years ago, when an engine was wanted, a contract for building the same had to be drawn up, preparations made, and from two to six months time would be required to produce it. It would be a cumbersome, slow-going machine with an immense fly-wheel, and occupying a considerable space in the factory, while the steam consumption would make it necessary to renew the coal supply rather too often, and constant attention would be required to keep the parts properly lubricated.

To-day, the N. Y. Safety Steam Power Co., can, as a rule, deliver any size of engine from two to two hundred horse-power at once upon receipt of order; their policy being to carry a stock of between four hundred and five hundred finished engines. Their engines are compact and substantial, quick-running machines, occupying little room (a 100 h. p. engine requiring but 9½ feet by 6½ feet floor space over all), noiseless in operation, fitted with automatic sight feed lubricators on every journal and pin, and requiring but half as much steam as the old style engine. They guarantee a coal consumption of between 2½ and 3 lbs. per horse power per hour for their single cylinder engines, while their compound engines show less than 2 lbs.

The class of engines referred to above are of the self-contained automatic cut-off type, and they possess advantages which recommend them highly for all industries where power is required, but more especially for electric light service, for the reason that direct connection may be made with dynamos and the most perfect regulation attained. For this reason it was thought best to employ them in the *World* building, N. Y., where they have given excellent satisfaction.

The engines are built on the system of duplication of parts, whereby, in the event of accident, a new part that will fit accurately may be obtained from the company's store at No. 30 Cortlandt street, at once upon receipt of order.

The promptness with which the N. Y. Safety Steam Power Co. can execute a contract is strongly illustrated by the following facts. A little more than a year ago, a prominent electric light company, who were using a number of these engines, met with a disastrous fire in which all the engines in their station were destroyed. An order was placed with the Power Co. for three engines aggregating six hundred horse power, and in nine days after the receipt of the order these engines were in full operation and have been running steadily ever since without a hitch. Pending the installation of this plant, three 150 h. p. Safety engines took this heavy load for the nine days without developing an overheated journal, or showing distress of any kind.

THE "H. C." PRESSURE INDICATOR AND REGULATOR.

THIS instrument, as shown in the illustration, Fig. 1, consists of a solenoid through the centre of which an armature composed of a bundle of soft iron wires moves, and is controlled by the attraction of the solenoid opposed by the force of gravity. In this way, the instrument, once set, will remain constant for an indefinite period, it not being dependent on springs whose power may change.

This instrument is arranged in connection with a circuit closing device so that when the E. M. F. rises above the standard at which the instrument is set a red danger lamp is lighted. If the E. M. F. falls below the standard a green lamp is lighted. When the pressure remains constant neither lamp burns. The object of this is obvious as the attention of the dynamo tender is called by the burning of either lamp and he can see at a glance whether the pressure is too high or too low and apply the proper remedy. The hard rubber plate carrying the solenoid and circuit closer is made to rotate upon the base so that the instrument can be set for any E. M. F. with a standard voltmeter.

An automatic device, Fig. 2, is supplied which can be used in connection with the indicator and operated by it, which, when driven either by a pulley and belt from a shaft or by an ⅛ h. p. motor, automatically throws in or out resistance, so as to bring back the normal pressure, thereby making it possible to keep the pressure constant on long feeders calculated to work under a high percentage of loss. The above apparatus is particularly designed for use in controlling the E. M. F. of a dynamo or the pressure at the lamps when run from a storage battery. This instrument is made by the Holtzer-Cabot Co., of Boston.

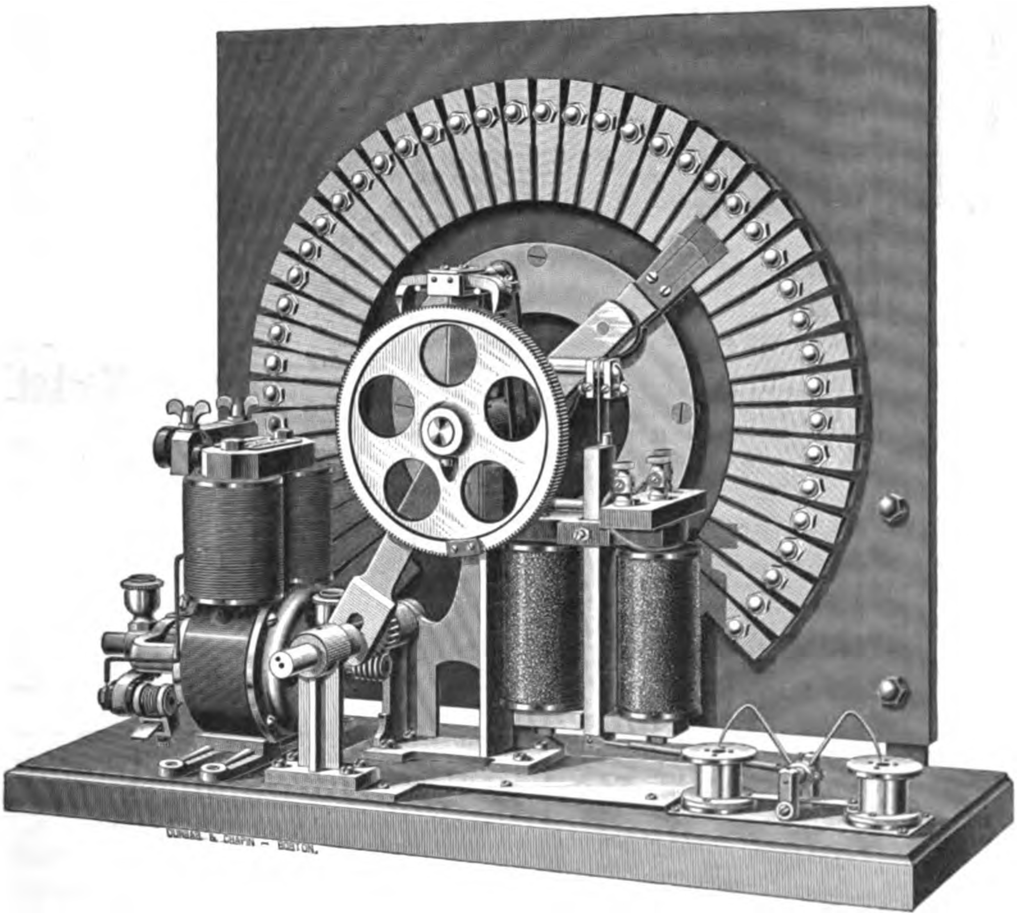


FIG. 2.—THE "H. C." AUTOMATIC PRESSURE REGULATOR FOR CONSTANT POTENTIAL CIRCUITS.

MR. DAVID PERCY, formerly engineer of the electric light plant at Scottdale, Pa., has accepted a position with the Novelty Manufacturing Company, of Allegheny City.

MR. W. L. ARNOLD, agent of the Thomson-Houston Electric Co., has secured contracts for 600 lights for the north and south end power stations of the St. Louis Cable Railroad and a 20 h. p. Thomson-Houston Motor for the Osage Mining Co., McAllister, I. T.

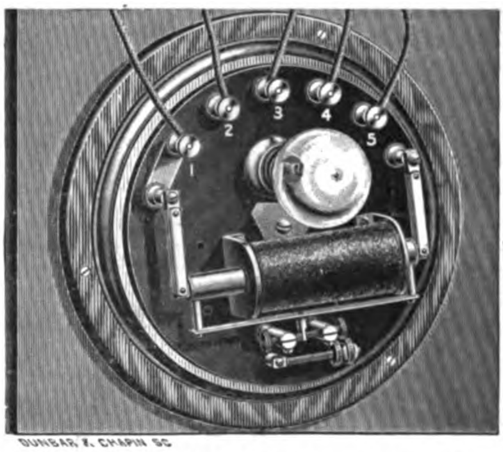


FIG. 1.—THE "H. C." PRESSURE INDICATOR.

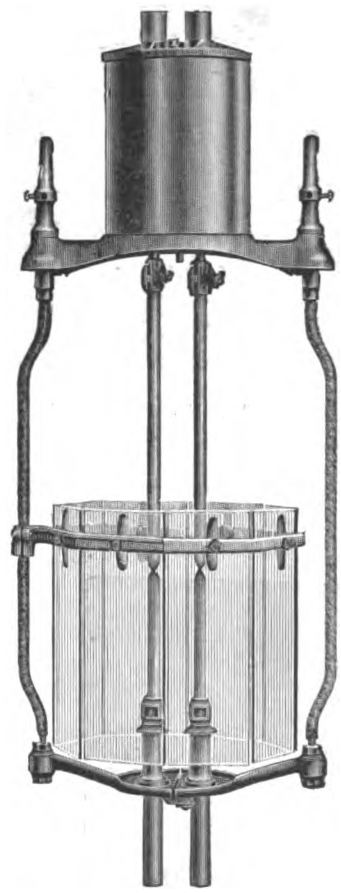
BOSTON, MASS.—Michael Creed has brought suit against Minot J. Kendall and others, to recover $10,000 damages. On July 17th, 1889, the defendants were engaged in putting up electric light poles, and had dug holes for the purpose, when a four-year old child of the plaintiff fell into one of the holes, receiving injuries which resulted in death on September 21st. This, the plaintiff asserts, was due to negligence on the part of the defendants.

The defence is a general denial.

FORT WAYNE, IND.—The suit recently brought by the Fort Wayne "Jenney" Electric Light Co. against Abner Crossman, Samuel and Simon Heavenrich, Louis Mendelssohn, Hugo Hill, Isaac Mendelssohn and Sigmund Simon, to recover on a broken contract said to have been entered into for the construction of storage batteries, has been discontinued in the Wayne circuit court.

THE GWYNN GLOBE FOR ARC LAMPS.

THE accompanying cut illustrates the Gwynn globe, which is being put on the market by the Western Electric Company, of Chicago, and New York. This globe possesses many points of superiority. It is made up of eight pieces of heavy French plate glass, securely bolted to a brass collar, which, in turn, is bolted to one side of the lamp. Being open at the top and bottom, it allows of carboning the lamp without removing the globe, and also prevents the accumulation of dirt and insects. If any plate is broken it can easily be replaced, without removing the globe from the lamp.

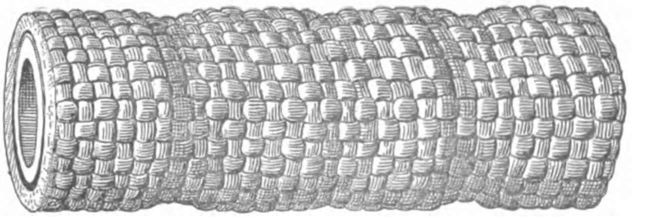


THE GWYNN GLOBE FOR ARC LAMPS.

A NEW FLEXIBLE GLASS INTERIOR CONDUIT.

WITHIN the last few years the subject of interior conduits for electric conductors has deservedly engrossed the attention of electrical engineers.

The much desired qualities in such a conduit are flexibility, insulation, and ability to resist fire, the first of these being a matter of the utmost importance, bearing directly on the cost of installation, and saving a large amount of labor. It also allows the installation of a conduit in old buildings without cutting the walls for the whole distance. The best insulator in use is glass, and if a conduit can be made of glass, and still be both waterproof and flexible, the desired end is, it is claimed, reached at once.



WRIGHT'S FLEXIBLE GLASS INTERIOR CONDUIT.

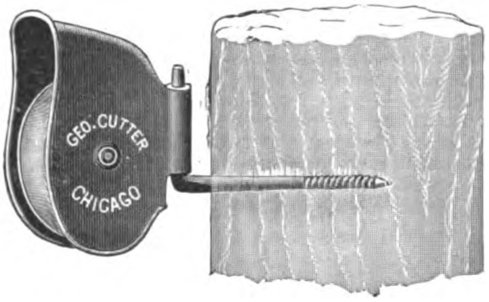
After much study, and many experiments, Mr. Alex. P. Wright, of Boston, has produced a flexible glass tube, which is said to be perfectly waterproof, and practically fireproof. It is shown in the accompanying illustration. The conduit is enclosed in a strong woven jacket, which gives it a high tensile strength, and a strong abrasion resistance, and the whole is then soaked in an insulating material. The system of connections is simple, and the cost for this item is quite small.

The American Circular Loom Co., of 620 Atlantic avenue, Boston, have undertaken the manufacture of this new conduit, which was exhibited at the Electrical Exhibition, at Providence during the Convention. There a section of it was shown connected with a lighting circuit and passing through a glass tube filled with water and bent twice at right angles in a sharp curve, thus showing the great flexibility and waterproof qualities of the conduit.

THE MORRIS SWIVEL POLE-PULLEY.

A LARGE percentage of the arc lamps used for outdoor lighting is hung from a cord passing over a pulley, and their safety must depend on the strength of this cord. Usually there is another pulley fastened to the pole, and the cord passes over this pole-pulley down to a cleat or windlass. Such a pole-pulley is, it is said, rarely found to be in line with the cord, and the result is that the rope scrapes on the edge of the pulley and wears out in a short time.

As a simple remedy for this chafing of the cord, Mr. E. P. Morris has designed a pole-pulley. As the cut shows, it is a sleet proof pulley which fits the upturned end of an ordinary pole-step and which can swing freely on this support. It is evident that such a pulley is quickly put up and will always stay in line with the cord. It can also be used as a wall-pulley, and other uses will suggest themselves to those who have found an ordinary pulley too rigid for many purposes. It is about to be put on the market by George Cutter, the "electrical specialist," of Chicago, who is also maker of the various electric railway specialties designed by Mr. Morris.



THE MORRIS SWIVEL POLE-PULLEY.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of Feb. 21, 1891, from New York, Boston and Washington; Pittsburgh, Feb. 21.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	81	Edison Gen. Elec. Co	100
American Tele. & Cable	80¼	Consol'd Elec. Lt. Co	...
Centl. & So. Amer	145	Edison Illn'g Co. N. Y.	79
Mexican	210	U. S. Elec. Lt. Co	30
Com. Cable Co	104	North Am. Phonograph	....
Postal Tel. Cable	39		

BOSTON.

	BID.		BID.
Thomson-Houston	45½	Ft. Wayne Co	18
" Pref'd.	25¾	Am. Bell	192½
" Series C	11¾	" Rights	17⅝
" " D	6¾	Erie	47½
" Int. Co	....	New England	50
Thomson Welding Co	....	Mexican	.65 cts
Thomson Eu. Welding	60	Trop. American	..
		Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BIT.
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PATTEN'S NEW ALTERNATING MOTOR.

AMONG the many ingenious arrangements for operating alternate current apparatus, devised by Mr. F. Jarvis Patten, our readers will recall one in which a three-wire system is employed. In this the outer circuits transmit, respectively, positive and negative impulses, while the neutral wire constitutes the return circuit for both. Recently, Mr. Patten has applied this system to a novel type of motor, which is shown diagrammatically in the accompanying engravings. These show, respectively, two successive positions of the armature, being in other respects identical.

The motor has two independent armature windings, each having its own commutator. There are also two separate field magnet circuits, and the circuits of each machine are so arranged that each receives the current in turn, while the other is cut out. A^1 and A^2 are the two independent Gramme rings, and F^1 and F^2, their independent magnetic circuits, respectively. The commutators are arranged in alternate groups of segments, the odd numbered groups, 1, 3, 5, 7, in each, being subdivided into segments connected to the ring winding in the ordinary way. The intermediate portions, 2, 4, 6, 8, are uncut, and all connected together as one. The brushes resting on both commutators are so arranged that their points bear upon the same line, parallel with the spindle to which both armatures are secured. From this it is evident that when the brushes bear upon the connected segments of one commutator, they bear also upon the intermediate, disconnected, segments of the other, so that one armature is short circuited, while the other is operative, and *vice versa.*

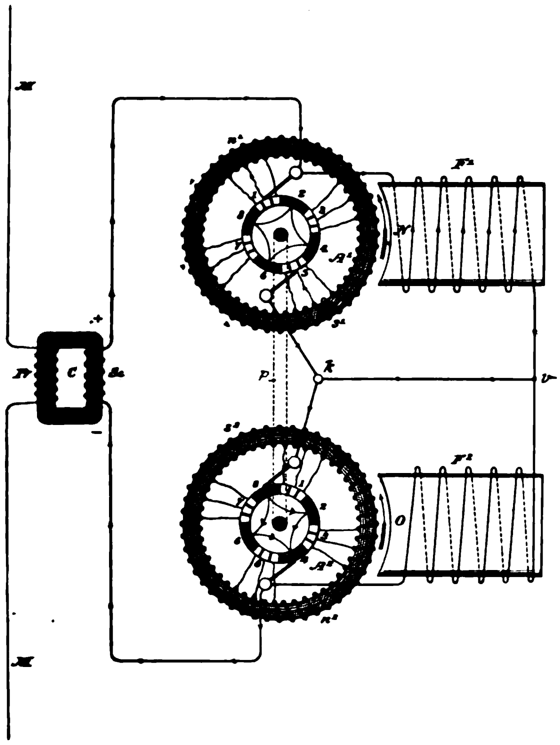


FIG. 1.—PATTEN'S NEW ALTERNATING CURRENT MOTOR.

It will be seen from Fig. 1, that the armature A^1 and its field F^1, are momentarily operated under the action of the positive current in the ordinary way, and whether the current be alternating or not, the tendency to rotation in the upper armature with respect to its field-magnet F^1 will be in the direction of the arrow, as shown, and motion will ensue. As the armatures turn upon the common spindle, shown dotted, they are eventually brought to the position shown in Fig. 2, in which the upper machine, having its brushes on the disconnected segments, is now cut out of circuit and is not operative, while the lower machine has come into a position where both its circuits, field and armature are in operation. This corresponds to the time period of a negative impulse, and these two phases of current, indicated in Fig. 1 by the single arrows and in Fig. 2 by the double arrows, indicating a reversed current, operate the two parts successively, one field and armature being operative, while the other, for the time being, is cut out of circuit, and each, for the time being, acts as an independent direct-current machine.

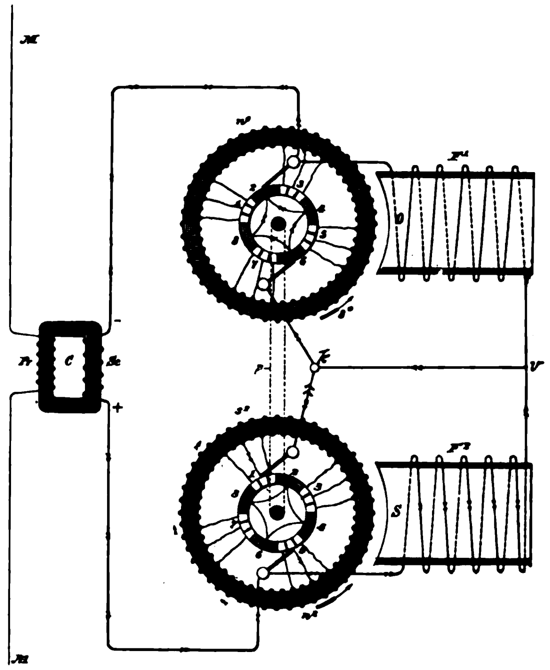


FIG. 2.—PATTEN'S NEW ALTERNATING CURRENT MOTOR.

The wire from K to V, common to both field-magnet circuits in shunt relation to their respective armatures, is one of the essential features of this system of motor-circuits. It amounts, in fact, to an application of the divided three-wire system of Mr. Patten, to the internal circuits of a motor. The armatures are connected in series relation to each other, the fields in shunt relation to their respective armatures, and each in turn made operative as the other is short-circuited. It will be seen upon examination of the circuits, that the converter secondary S C is therefore always working through the same resistance, as each machine, in turn, is cut into its circuit, while the field-magnets, after synchronous motion has been obtained, keep a constant polarity, by reason of the fact that each in turn gets a succession of positive or negative impulses, and the same holds true of the armature circuits.

THE BEACON VACUUM PUMP FOR EXHAUSTING INCANDESCENT LAMPS.

In the manufacture of incandescent lamps it is a question of the greatest interest whether non-mercurial, metallic pumps will supersede the present well-known forms in which glass and mercury are used for the production of vacua in the lamp globes. While the mercurial pumps produce excellent results when properly used, they labor under many disadvantages, among which may be mentioned the following: Extreme slowness of operation, lack of uniformity in results, the necessary investment of large amount of capital, great cost of maintenance, ill effects upon the health of the operators, and the requirement of a large amount of floor space. Nevertheless, until recently, it is only these pumps which have been found capable of producing the fineness of work required in the manufacture of incandescent lamps. The problem of producing a non-mercurial pump capable of attaining the necessary perfection in its work has been surrounded with so many difficulties, that nearly all who have given the subject attention have come to believe that the problem was practically unsolvable; very few, therefore, who were capable of dealing with so difficult a subject have given their best endeavors to it. Consequently, this field for invention has, until quite recently, been barren of results.

An ordinary knowledge of mechanics was not sufficient, evidently, to solve this problem, as the inventor was at once met by such difficulties as were offered by the porosity of metals, the impossibility of making mechanical joints and moving surfaces perfectly air-tight, as well as the difficulty of expelling all the air from the pump cylinder at every stroke of the piston, and many other difficulties too numerous to mention.

In order to counteract the porosity of the metals used in the construction of a non-mercurial metallic pump, and to render the joints and moving surfaces perfectly air-tight, it is necessary to use a sealing liquid of some kind. It is quite evident, that in order to answer its purpose, this liquid should possess certain unusual and indispensable qualifications. For instance, it must be non-corrosive, it must possess no volatile constituents, and must be a lubricator. Among the liquids furnished by nature and by the laboratory there are very few, indeed, which are not volatile to a very considerable extent. Those which are most nearly non-volatile, and which, at the same time, are non-corrosive and also lubricators, are confined principally to that class comprising the fixed oils, either animal or vegetable. But even these, in the form in which they occur, contain a greater or less amount of volatile impurities which must be eliminated, and different oils properly compounded before a liquid is obtained suitable for use in a pump for high vacua.

Furthermore, all these fixed oils absorb and carry with them a considerable amount of air and other gases. If this absorbed air is removed these liquids will, on again coming in contact with the air, re-absorb it; so that, in order to use them in high vacuum pumping, they must not only be freed from absorbed air, but must be continually kept in a deaerated state. When deaerated oil is exposed to air, though under but slight pressure, only a few seconds are necessary for so much absorption to take place that a fine vacuum would be lost by the introduction of a small quantity only of such oil into it. From this it is obvious that unless a non-mercurial metallic vacuum pump is sealed both inside and outside by a non-volatile and thoroughly deaerated liquid, no hope of success can be entertained. Mercury, it is true, does not absorb air to an appreciable extent, but it cannot be used as a sealing medium for metallic pumps, for the reason that it is not a lubricator and will amalgamate even with steel and iron under the conditions in which it exists in the cylinder of a vacuum pump, and further, it does make an air-tight joint with a metal, as it does with glass. This has been demonstrated by expensive experiments. Neither can mercury be used in combination with oil, as they form a paste when agitated together. It is not our intention here to follow through all the experimental stages leading up to a knowledge of the principles already set forth, but we will at once proceed to describe the "Beacon" vacuum pump, which, we may safely state, is the embodiment of a comprehensive understanding of the foregoing principles among many others.

We cannot at present give our readers an exact drawing of the precise form and details of the pump as it is built to-day by the Beacon Vacuum Pump and Electrical Company, of Boston, but will consider some of its most important elements which have been recently patented and which are illustrated diagrammatically in the accompanying engravings.

The method of jacketing or outside sealing of the vacuum pump by deaerated oil or other liquid, a most important feature, is shown in Fig. 1. Here A represents the inner cylinder of a vacuum pump, and A^1 the jacketing cylinder. The space S between the two cylinders is closed at all points so that no air can enter it. B represents the bottom of the cylinder proper, and B^1 the bottom of the jacketing cylinder.

The valves used consist of a valve D, serving to admit air from the chamber being exhausted; and of a second valve E, through which the air is to be expelled. The above described valves are not operated by the pressure of the air, but are provided with mechanism which causes them to act independently of the air, and at such times as the best action of the pump requires.

M is a reservoir for oil located above the spaces in and about the pump, so that the oil will flow by its gravity, unless checked, from the reservoir to the spaces to be sealed. This reservoir is connected by the pipe K^2 to a force pump K^1, and through the force pump by the pipe K to the jacketing spaces S, S^1, S^2 of the vacuum pump. The circulation of the oil being completed through the pipe L, weighted valve L^1 and pipe L^2.

In the illustration an auxiliary air-pump M^1 is shown immediately over the oil reservoir.

The mode of operation is as follows: The oil is placed in the reservoir M, thence made to fill the circulation pipes and spaces S, S^1, S^2, of the vacuum pump to be sealed. Now if the apparatus be started, the oil in the reservoir M, will be subjected to a vacuum and its embodied air will expand and rapidly leave it in a deaerated condition; as the movements go on, all of the oil in the circulation pipe and in the sealing parts will become deaerated to such a degree that no more air can be drawn from the oil, and thus the oil becomes a medium properly adapted for the purpose of sealing. If the oil in its circulation becomes, from any cause, re-aerated, as it readily absorbs air when brought in contact with it, it is again restored to its airless condition by the continued action of the vacuum in reservoir M.

The reason why the sealing or jacketing liquid in a vacuum pump must be deaerated, in order to secure success, is, as alluded to above, that if not so treated, in its gradual leakage through the walls and joints and past the moving parts of the pump, it would carry with it its absorbed air and give it out on the interior, thereby rendering the attainment of a high vacuum impossible.

We now come to the method employed of completely expelling the air from the cylinder at each stroke of the piston, the principle of which is shown in Fig. 2.

It is not a new thing to introduce a liquid into the cylinder of an air pump for the purpose of expelling the air at the termination of each stroke. Several of the large steam air pump manufacturers have used water for this purpose; but their pumps were not designed for high vacua. In pumps for the latter class of work it is essential that the air should be completely expelled from the cylinder at the end of each stroke. To accomplish this result a liquid must be used to fill the interstices under and about the piston, thereby expelling all the air. This, as shown in Fig. 2, is accomplished by forcing at each upward stroke of the piston, a quantity of the deaerated oil into the cylinder, which serves to fill all of the unoccupied space under and about the piston when it is at its lowest point, thus expelling all air; during the downward stroke of the piston all excess of oil is forced out of the cylinder into a vacuum tank, in which tank the air that has been taken up by the oil during the descent of the piston will be withdrawn, and the oil will be ready to be again forced (in its deaerated condition) back into the cylinder, from which its excess is again expelled and returned to the deaerating tank, this circulation and deaeration taking place at each stroke of the piston.

An ingenious method of making an air-tight connection between the leading pipe of the vacuum pump and the glass stems or forks by which the lamps are attached for exhaustion, is shown in Fig. 3

The Beacon pump is intended to exhaust a large number of lamps at one operation, and the question naturally arose, What will become of all these lamps if a globe should break or a sudden leak occur while they are burning on the pump and the filaments are at incandescence? The answer to this question was obvious. They would be destroyed before the hand of the operator could shut off the current. To overcome this difficulty the simple arrangement shown in Fig. 4 is employed. By it an influx of air into the vacuum system, even if very slight, opens or closes, as the case may be, through a mercurial manometer, a secondary circuit, which, operating through an electro-magnet, instantly cuts off the main current from the lamps. The operation of this device would require but a small fraction of a second and by it the danger of injuring a large number of filaments by an inadvertent break is eliminated.

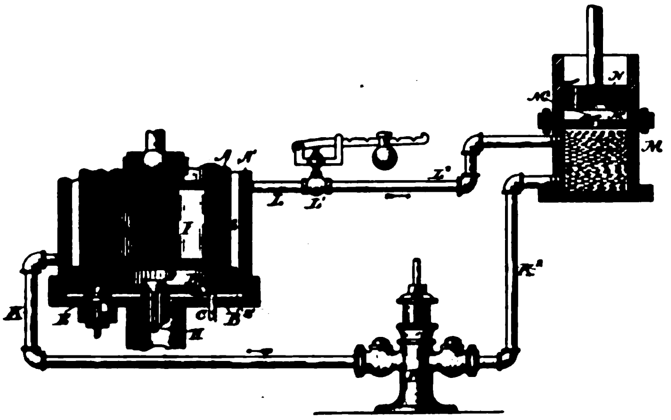


Fig. 1.—The Beacon Vacuum Pump.

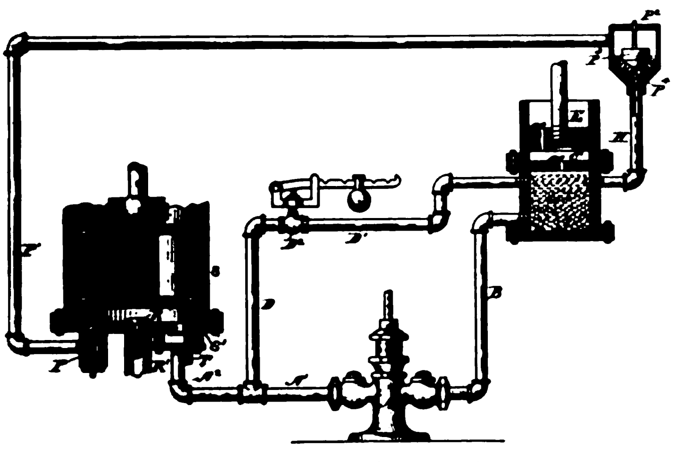


Fig. 2.—The Beacon Vacuum Pump.

Incandescent lamps exhausted on the Beacon non-mercurial pump are claimed to have some characteristics which distinguish them from those made by the mercurial process. These two kinds of lamps do not answer all tests alike. One reason for this may be explained as follows: By no process of exhaustion is the vacuum absolutely perfect. Attenuated vapor or gas of some kind always remains. With lamps exhausted by the mercurial apparatus this attenuated remainder consists of air and mercurial vapor. In those lamps exhausted upon the Beacon pump it consists of air and a certain amount of hydro-carbon vapor derived from the oil used in the pump. It is quite natural to suppose that these two kinds of lamps should respond somewhat differently to the different tests to which they are subjected. For example, what is known as the induction coil or spark test shows more color in lamps from the Beacon pump than is given by the best specimens of mercurial work. However, it is only the best specimens of mercurial work which are able to make a better showing by this test. But it should not be assumed from this that the mercurial lamps have a better vacuum, simply because they may show a trifle less color by the spark test, since the two kinds of lamps contain vapors of a different quality. This reservation of opinion is justified by the fact that, when carefully opened, under clean, dry mercury, the remaining bubble of air is smaller in the lamps from the metallic pump than in those from the mercurial pumps, except, perhaps in an occasional specimen of super-excellent mercurial work.

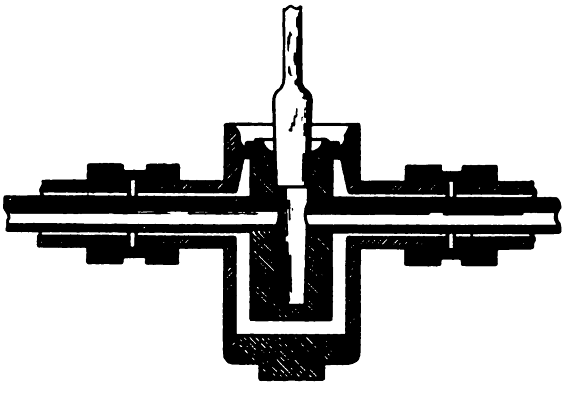


Fig. 3.—Joint of Beacon Vacuum Pump.

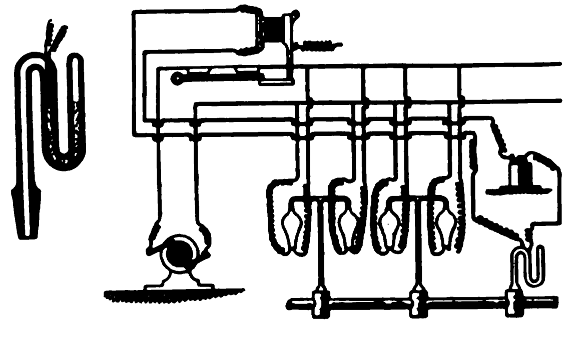


Fig. 4.—The Beacon Vacuum Pump.

Nor is this said to be the only testimony in favor of the excellence of the results obtained by the mechanical oil-sealed pump, since numberless experiments have shown that the vacuum in a lamp from the Beacon form of pump improves more rapidly on burning the lamp (leaks excepted) than in that of a mercurial origin. The experiments referred to were to open carefully, under mercury, lamps of both mercurial and metallic pump origin, which had burned from a few hours up to many hundred. Hundreds of these lamps have been so tested, and the fact brought out that whereas the mercurial lamp, after burning a considerable time, showed an average of less residual air than new lamps of the same make, lamps from the metallic pump under the same conditions showed either microscopical amounts of air remaining, or, as was very often the case, filled so completely that no residue could be observed.

Still another test by which the non-mercurial lamps are claimed to have shown their superiority is their ability to endure over-voltage. Many experiments have been tried in which lamps, some of which were exhausted mercurially and some by the metallic pump, the filaments and other portions of the lamps being of the same make, were burned above their normal voltage and intended candle power. In these tests the lamps having the non-mercurial vacuum have almost invariably out-burned their rivals. This superiority and peculiar action of the non-mercurial vacuum is attributed to the probable decomposition of the hydrocarbon vapor of the oil, its carbon depositing upon the heated filaments and the small residue of hydrogen disappearing in some way unknown. The question of the quantity of work that can be accomplished by means of the Beacon pump depends merely upon the size of the machine, which, in contradistinction to the mercurial pump, can be built of any proportions desired.

The inventors who have produced this successful pump are Mr. Adolph Berrenberg, of Somerville, and Mr. William E. Nickerson, of Cambridge, Mass. Mr. Berrenberg was the first in this connection to entertain the idea that a metallic vacuum pump could be built suitable for incandescent lamp work, and pursued his experiments for several years.

Mr. Nickerson, who is a graduate of the Massachusetts Institute of Technology, became associated in the enterprise about a year ago, and since that time many improvements have been added and many experiments performed. The Beacon Vacuum Pump Co. have a large and well-equipped factory in Boston for manufacturing their pumps and are also carrying on considerable experimental work upon incandescent lamps.

A NEW STORAGE BATTERY PLATE.

BY

Henry U. U. Currie

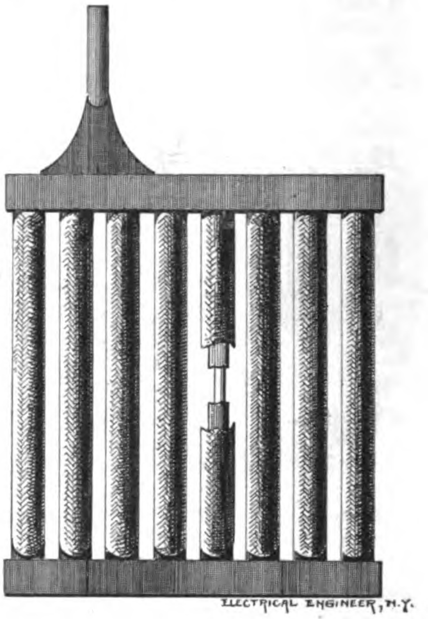
THE plate, which is illustrated in the accompanying engraving, has been devised with a view to overcoming what have hitherto proved the principal objections to storage batteries, namely, the disintegration and gradual falling away of the active material, more especially the peroxide of lead in plates constructed of this metal. There are, however, other advantages in this particular form of plate, one being the large relative amount of surface exposed to the action of the electrolyte.

The active material is in the form of a thin layer, no part of it being more than one-eighth of an inch from the internal support, while the latter is entirely encased, and therefore not exposed independently to the action of the electrolyte. In the accompanying engraving a part of the support frame is shown exposed at the top and bottom, but in the later plates all parts below the surface of the liquid are encased within the active material.

The principal feature of this form of plate, however, consists in the active material being entirely encased within a sheath or covering of asbestos tubing. The fact of this covering being in the form of a tube ensures the essential feature of strength. The asbestos is first braided in tubular form and of the required thickness. This is then cut up into lengths, eight of which are placed in a special mould, each tube, when in this mould, having a brass removable rod (of the same length as the asbestos but of considerably less diameter) passing up the centre. By means of a suitable inlet a fused salt of lead, such, for instance, as the chloride of lead, is poured into the mould and fills up the spaces intermediate between the brass rods and the asbestos tubing. The brass rods are then withdrawn, leaving the chloride of lead in a compact tubular form, the whole having an outer coating of wires or braided asbestos. The next step is that of filling the spaces lately occupied by the brass rods with pure lead or an alloy of lead and antimony, and at one and the same operation casting on a connecting bar of the same metal to hold the rods in place and to form the necessary connections.

The chloride of lead is then reduced to a state of porous lead and the plate is now ready to be fitted up and "formed." These plates after being formed can be used in conjunction with negatives of a similar type or with flat negatives of the ordinary type.

It might be supposed that the asbestos coating would introduce an appreciable resistance, but severe and continued tests have so far proved that this is not the case. Quite a number of cells, consisting of ten positives of the above described form, and eleven negatives of the ordinary flat type, have been subjected to most severe tests as regards charging and discharging and the way they maintain their E. M. F. is most remarkable. One plate, weighing about 1¾ lb., has been for some months subjected to continuous chargings and dischargings at a rate of 30 amperes and still looks "hale and hearty," and when recently tested at lower rate for capacity gave the same results as when first put up, namely, 20 ampere hours.



CURRIE'S NEW STORAGE BATTERY PLATE.

The plates have recently been greatly improved in shape, and, what is of great importance, a very simple, novel and inexpensive method of manufacturing them is now in operation.

SOLDERING GLASS TO METAL.

AT a recent meeting of the Société de Physique, M. Cailletet described a process of soldering glass and porcelain to metal. The glass tube to be soldered is first covered with a thin coating of platinum or silver, by treating it with a film of platinum chloride or silver nitrate and heating to dull red. A ring of copper is next electro-deposited on the platinised tube, which can then be soldered like any ordinary metallic tube. Solderings effected in this manner are said to be very strong. The top of a tube attached to M. Cailletet's apparatus for liquefying gases terminates in a soldered end, and successfully resists pressures of over 300 atmospheres.

THE NEW WENSTROM STREET CAR MOTOR.

AMONG the first to recognize the importance of reducing the number of gears in electric street cars was the Wenstrom Consolidated Dynamo and Motor Co., and as a result they, some time ago, adopted a slow speed motor geared direct to the driving axle of the car. The design of the new motor, which is illustrated in the accompanying engraving, Fig. 1, is due to Mr. H. F. Parshall, and while he has retained the general principles of the Wenstrom dynamo, he has so far surpassed any results heretofore obtained in this machine, that the marked superiority of the motor is fairly due to him.

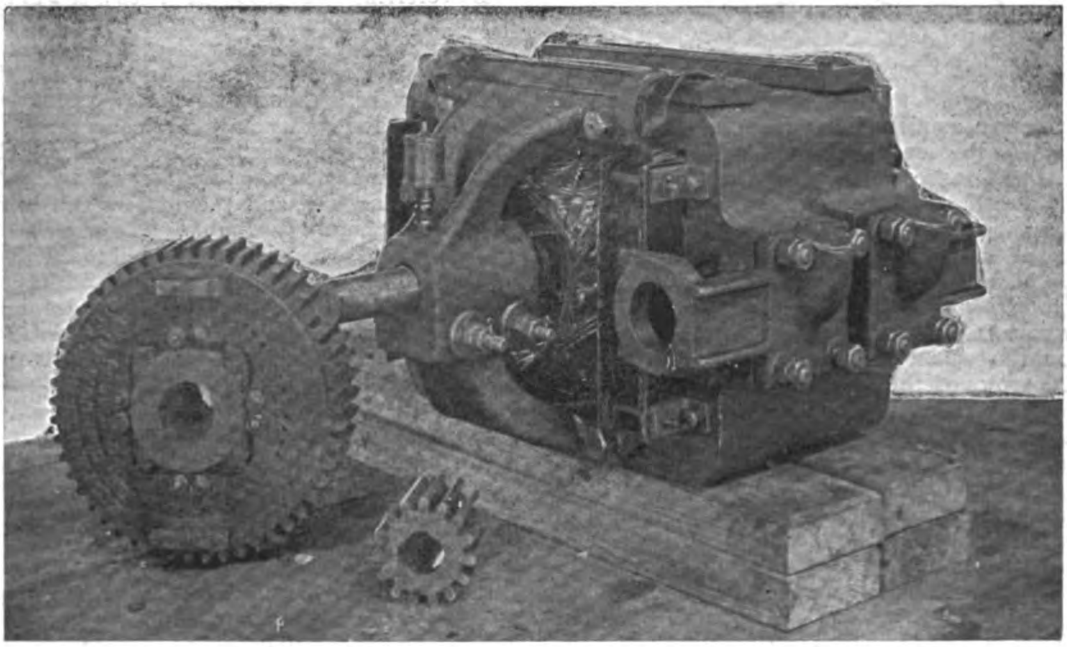


FIG. 1.—NEW WENSTROM "SLOW SPEED" CAR MOTOR.

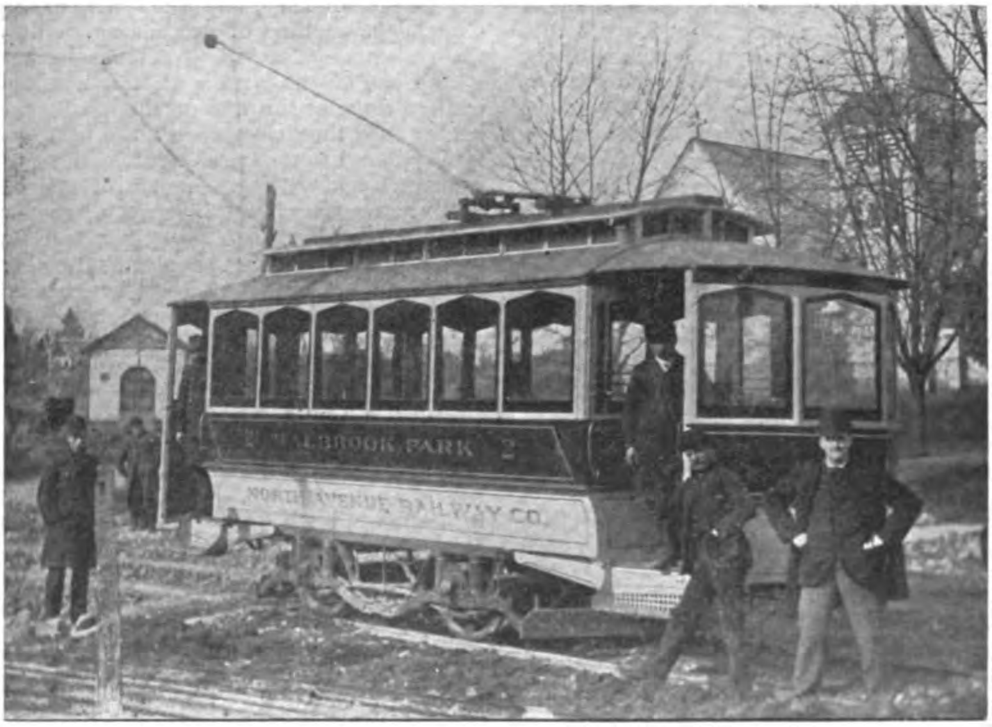


FIG. 2.—WENSTROM SINGLE MOTOR CAR, NORTH AVE. RAILWAY, BALTIMORE, MD.

The armature makes but 400 revolutions per minute, so that the necessity of a countershaft is obviated, the gearing being direct through a strong armature pinion.

The car, shown in Fig 2, has been in daily commercial operation on the North Avenue Railway, in Baltimore, for several weeks, during which time it has proven very satisfactory.

The car is equipped with but a single motor, and in a recent test made by Mr. L. N. Frederick, the superintendent of the road, he gives the following data of its performance: "The voltmeter at our power station, while the Wenstrom car is climbing our heaviest grade, which is 7 per cent., registers 490 volts, showing a loss of but 20 volts, and the amperemeter registers 20 amperes. Our car having the two motors shows a loss of 90 volts on this grade, registering 420 volts, while the amperemeter records from 40 to 60 amperes."

The car, according to Mr. Frederick, runs with less noise than an ordinary horse car, owing to the noiseless gears, and with an entire absence of a jerk on starting.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XV.

(*Copyright, The Electrical Engineer.*)

BY

Herbert Laws Webb

THE battery power employed for resistance tests need not be high unless the length of wire to be tested, and consequently its resistance, be very great. For ordinary measurements five cells of battery are ample.

The connections being made as indicated, the ratio coils should be adjusted according to whether the resistance to be measured be high or low, and the coils should be unplugged so as to throw in circuit an amount of resistance approximately equal to the unknown resistance. The galvanometer should be shunted with the $\frac{1}{10}$ or $\frac{1}{100}$ shunt to prevent violent throws of the needle if the balance is very uneven at first. Assuming that we are working with the Post Office bridge, the battery key should now be depressed and the galvanometer key tapped lightly, and the direction of the deflection observed. It will depend upon the battery and galvanometer connections whether a movement of the spot to the left indicate too high or too low resistance in the coils, but this can readily be ascertained by varying the resistance considerably and noting the result. If the movement be at first to the left and the addition of a number of ohms result in a deflection to the right of the zero, then to the left means not enough resistance in the coils, and to the right, too much. These indications will, of course, have opposite meanings when the battery is reversed. It is usual to put the zinc or negative pole to line, but in testing a wire of any length with one end to earth it is necessary to take a number of readings with both currents, the mean of all the readings being taken as the resistance of the line. This method is required on account of the earth currents which occur in long lines connected to the earth, and which modify the apparent resistance of the wire when measured with different poles of the battery to line. In a long submarine cable having a total resistance of several thousand ohms, the difference between the resistance measured by the zinc current and the resistance measured by the copper current will be sometimes as much as one thousand ohms, but the mean of a number of readings made with each pole to line alternately, will give the correct resistance of the cable.

The battery key being held down and the galvanometer key tapped from time to time to ascertain whether to increase or diminish the adjustable resistance in circuit, the adjustment can rapidly be made by manipulating the plugs until the spot remains on the zero of the scale. When balance is nearly effected, the shunt should be decreased, and finally removed altogether, so as to obtain the maximum sensitiveness of the galvanometer in arriving at the final balance.

As a general rule in measuring the resistance of land lines, whether overhead or underground, the distant ends of two wires are joined together and the resistance of the loop is taken. The resistance of each wire is then half the resistance of the loop. This, of course, is only permissible when the two wires are of equal length and of the same diameter.

If the conductors to be measured are connected to the instruments by long leads, the resistance of the leads should be measured, their ends being connected together and the test made in the manner described above. The resistance of the leads must be deducted from the observed resistance of the wire or cable being tested.

In measuring the resistance of a long line where only one end is available, the distant end being put to earth, several readings should be made with each pole of the battery to line; the mean of the several readings will give the actual resistance of the wire. In measuring the resistance of a loop or metallic circuit, a single reading with either pole of the battery will be sufficient; no connection being made with the earth, there is no chance for earth currents to affect the readings.

By referring to Fig. 35 (see p. 195), it will be seen that the dial bridge, besides having the advantage of a greater range of resistance, is somewhat more convenient to use (where the instruments are permanently set up) than the Post Office pattern, although the latter has no equal as far as portability and compactness are concerned. With the dial bridge the ordinary battery key is used, and the battery can be turned on and kept on without the necessity of holding down a spring key, and the battery can be reversed when requisite without any trouble. The wires from the ends of the proportional coils are connected to the short circuit key of the regular set of instruments, and by means of this the galvanometer is opened and closed for observing the progress toward effecting a balance. There are fewer plugs to manipulate, and the amount of resistance can be read directly from the dials. This renders work somewhat quicker than with the Post Office bridge. A very quick acting dial bridge is made by having a revolving arm pivotted to the block in the centre of the dial, the under surface of the arm making a rubbing contact on the sectional blocks. In this way plugs are dispensed with altogether and measurements can be made with great rapidity owing to the extreme ease with which the adjustment can be made. Such an arrangement, however, is open to the objection that resistance might be introduced at the contacts owing to wear at the bearing of the revolving arm, and insufficient pressure between the lower surface of the arm and the blocks. The possible error from these causes, if the instrument is thoroughly well made, should be very small, and where very great accuracy is not absolutely essential, a bridge of this type would no doubt meet with much favor, owing to the saving of time effected by its use.

The operation of measuring the resistance of a conductor is a very simple one, and a practical example will suffice to explain the method of proceeding. We will assume that the resistance of a wire five miles long is to be measured. If the end of the wire is directly available it is connected to the bridge at the end of the proportional arm, or, if a lead is used the resistance of the lead is taken first. The lead is found to measure .36 of an ohm. The wire is then connected and a certain amount of resistance is unplugged in the coils, approximately equal to what we believe the resistance of the wire to be. This resistance being a comparatively low one, the proportional coils are unplugged in the ratio of 10 to 100, 10 in the arm next the cable and 100 in the arm next to the adjustable coils. In this way the resistance in the coils will be ten times that of the cable, and we can make the measurement with greater accuracy. The galvanometer should be shunted, as probably the first trial will not nearly give balance and there will be a rush of current through the galvanometer causing a violent deflection when the short-circuit key is opened. The key should be lightly tapped, and not held down until balance is nearly obtained. Having plugged 1,500 ohms in the adjustable coils, we find on tapping the short-circuit key that this is not enough, and more resistance is added until the deflection is lessened and finally commences to rise on the opposite side of the scale. As we approach a balance the shunt is removed, giving the maximum sensitiveness of the galvanometer. When the deflection begins to be on the opposite side of the scale the resistance in the coils is slightly decreased and balance is obtained, *i. e.*, the spot remains on the zero mark with the short-circuit held open, with 1,745 ohms resistance in the coils. The resistance of our cable is therefore 174.5 ohms; subtracting .36 ohm, the resistance of the lead, we get 174.14, and, dividing by five, we find that the conductor has a resistance per mile of 34.828 ohms.

When possible, as in measuring the resistance of wires in cables containing a number of conductors, it is better to join a pair of wires together at the distant end and take the resistance of the loop. The two ends are connected to the bridge, and the two battery wires also, all ground connections being dispensed with. The figures obtained must, of course, be halved to give the resistance of a single conductor.

A PROBLEM IN PHOTOMETRY.

BY

Rufus B. Aisey.

With reference to the "Problem in Photometry," submitted by "A. T." in The Electrical Engineer of Jan. 28th, permit me to offer the following, as possible solutions to the questions propounded.

No. 1. If in a photometer, the distance from flame to scale is used in the determination of the value of the light, the interposition of a screen with a hole in it will allow but a portion of the beams to pass the obstruction, therefore the distance from the flame to the screen would appear as the proper measurement of the power of the candle.

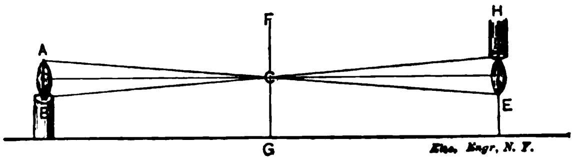


Fig. 1.

In Fig. 1, let AB represent the flame or unit, and its light projected upon a scale placed at H. If a screen, F G be interposed (which for readiness of comparison is placed midway between scale and light), the power of the candle is diminished by exactly the number of rays failing to pass the screen, which would be exactly ½, hence the light of one candle power having a screen interposed, would be reduced in intensity ½, or the distance from screen to candle, or screen to scale. If the screen were moved closer to the light, the image on the scale would be fainter, until the relative positions of the two were restored.

This may be proved by substituting for the drawing or scale, a sheet of plain unruled writing paper, folded crosswise of the sheet so as to present a square, whose centre shall coincide as closely as possible with the centre of the flame under discussion.

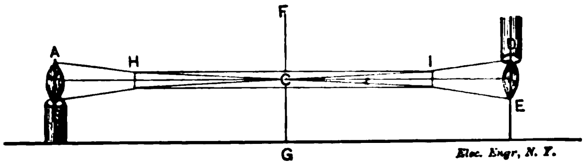


Fig. 2.

Now, letting the folded paper stand on edge, with the sides open at an angle of 45°, at any given distance from the light, and by placing another light equi-distant, the lights presumably having the same power, it will be found that the folded paper, being equally illuminated on both surfaces, presents a perfectly flat appearance, giving no indication of being interposed between the two lights. Now, if a screen be placed at a point midway between the apex of the paper and either of the lights, the reducing of the beams in parallel will necessitate a moving of both screen and light closer to the paper, until the lamp will occupy the point where the screen was first interposed, and the screen will still be midway between the paper and light, when the illumination of both sides of the paper will again be equalized, and appear as a flat surface.

In proposition 2, we seem to have an absurdity, but taken within reasonable limits, it would appear capable of the same solution or answer as proposition 1.

As an absurdity it would only be necessary to exaggerate the length of the tube until it reached both flame and scale, or to have the light-passing capacity of the tube reduced to microscopic fineness. But, while in my sketch I have somewhat exaggerated, yet I have kept within reasonable bounds.

Let H-I Fig. 2, represent the screen or tube. It is very evident that only those rays of light will be enabled to pass, which can be passed parallel to the tube, thus forming a round beam, slightly larger than the tube, upon the scale. Let us now suppose that through a suitable aperture in the centre of the length of this tube, a screen be introduced; the parallel beams are immediately made to come to an apex, and after passing their point to again diverge, until upon the scale the image is again shown as in the first proposition.

If the conditions of the question propounded were altered to make the tube begin at AB and gradually narrow to a point at C, thence expand again until it reached the scale at DE, the proposition would be answered by the conditions attached to Fig. 1, and may be also considered as answered under the same conditions in Fig. 2.

For the 3rd problem, we have entirely different conditions existing. Here a light placed in the focus of a concave or parabolic mirror has both the direct as well as the indirect rays utilized, and thereby the power of the light is increased. Now to get at a measure of this increase in power, let us substitute a double concave lens for the mirror, and place the lamp behind it; it will be found that the lamp will be in position at a point measuring the same behind the lens as before it; consequently in estimating for the distance or measurement to the scale, the measure should be taken from a point as far behind the mirror as the light is in front, which would be the radius of the mirror. Now, presuming the image of the inverted candle to be thrown upon the scale by placing a screen or diaphragm, as in Figs. 1 and 2, the proper position of the screen will be found to have been moved to a point nearer the scale, by a distance equal to the radius of the mirror. Hence, the deduction from the premises, that, to obtain a measuring point for the power of a light placed in front of a parabolic lens or mirror, a distance corresponding with the radius of the lens should be added to the distance of the lens from the scale in computing the candle power.

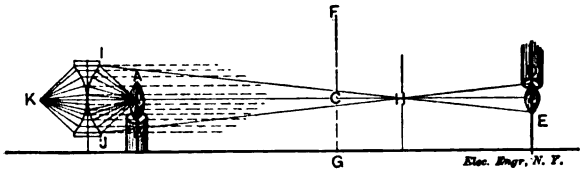


Fig. 3.

THE MEASUREMENT OF LARGE CURRENTS.

For the accurate measurement of large currents, such as are obtained from accumulators, F. Himstedt makes use of a tangent galvanometer, with two consecutive copper rings, each 1cm. broad and .4cm. thick, of radii 23.276 and 27.422 cm. respectively. These rings are connected in opposition, so that the needle is acted upon by a differential couple. The advantages of this method are that the measuring apparatus is inserted in the actual circuit, that only a single observation is required, and that no resistance measurements are necessary.

THE CARBON BRUSH FOR DYNAMOS AND MOTORS.

BY

Edgar A Sweet -

THE frenzy which has taken hold of electrical inventors is throwing many intricate devices upon the market, which keep the studious electrician of the present day up to his ears in electrical technology; of these devices many, indeed, are meritorious, possessing qualities that at once recommend them to foremost positions. But so eager are some of our inventors to rush their apparatus upon the market, in order to gain priority over others, that often the device is wanting in its most essential requirements.

We all know what the principle of dynamo machinery is—an armature moving in a magnetic field—and of the various types of this class of machinery; but they all seem to fall short in one most important point, important at least to the business manager of an electric plant, namely, the device for collecting or transmitting the current from, or to, dynamo electric machinery. There are some dynamos that would require a three-length commutator in order to offer surface enough for the collectors to carry off the enormous current generated.

A low potential current is the most difficult one to handle by means of either copper or carbon collectors, and it is impossible with the present carrying capacity of the collectors, to carry it off without more or less damage to collectors and commutators, and, in most cases, to the final destruction of both. It is thus only a question of time when every dynamo and motor must be supplied with new commutators, the collectors themselves having in the mean time been replaced many times. The causes for this trouble are various. If one tries to carry 40,000 watts on a 22,000 watt dynamo, which is too often the case, the commutator and collectors will shortly have to be replaced by new ones. If the copper wire or leaf brushes are allowed to acquire a long surface at their contact points with the commutator, sparking is sure to ensue at the brushes, and the longer they are left in this condition, the greater is the rate of destruction.

A sparking machine should be attended to immediately; the first point of attention being the brush contacts: Are they good? Are they properly set? Do they make contact upon diametrically opposite segments of the commutator? If more than one brush to a pole is used, are they at *adjacent* contacts? This, however, cannot be set down as a fixed rule. I have found by experience that one brush is not as efficient as two, or more, of the same surface contact, for giving one brush a small lead will, in many cases, stop all sparking; this is especially so with brushes that bear upon the commutator endwise, as shown in the engravings, Figs. 1 and 2, and unlike the old leaf brushes that strike the commutator at an angle of 40 degrees and are constantly working their fingers over the segments, to the final ruin of the commutator. These endwise brushes bear upon the commutator nearly at right angles with the commutator axis, and are consequently always the same in their action.

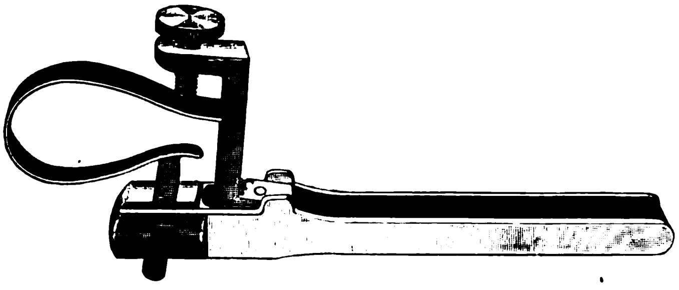


FIG. 1.—THE SWEET CARBON BRUSH.

The form of carbon brush illustrated is adapted to most forms of dynamos and motors, and, where the carrying capacity of the brush is sufficient, will give the best results. This form has been applied to dynamos where the old copper brushes could barely be kept in a running condition; dynamos generating a high potential current will take to this brush and run for years without the slightest attention. I have in mind a machine that would not cease its sparking (and this even at the high tension rings of an alternator) while running with copper wire brushes; but the application of this form of carbon brush stopped all sparking, and the machine did not, in one year's time, wear one-tenth of an inch from the one-inch carbons that were placed in the holder slip. The result was remarkable, and the commutator remains to-day as smooth as when first turned off, more than one year ago.

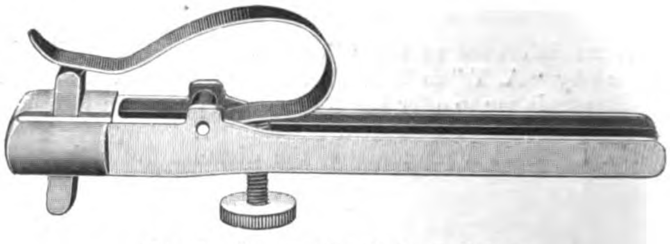


FIG. 2.—THE SWEET CARBON BRUSH.

A carbon brush that presses vertically, or nearly so, on the commutator, must, according to dynamic laws, give better results than a brush placed at an angle of 90°.

A collector is supposed to be thick enough at its commutator contact end to exactly cover one of the coil segments. The brush that bears at an angle of 90° will wear at the point of contact, drawing it out over the commutator until it covers more than one segment or coil, thus causing a short circuit of one coil in the series wound armature. Sparking will then follow; the commutator and armature will heat, not only from the sparking, but because one or more of the armature coils are partly, or wholly, short-circuited, and generating heat; and, finally, if the brush contacts grow too long, the armature will burn out.

PARAMAGNETIC AND DIAMAGNETIC BODIES.

A NOVEL distinction between paramagnetic and diamagnetic bodies has been pointed out by M. P. Joubin in the current number of the *Comptes Rendus*. For those metals which obey Dulong and Petit's law of atomic heat, it is possible to calculate quantities which are proportional to the number of molecules contained in a unit volume, and hence the average distance of the molecules from each other can be compared. When these distances are examined in connection with the corresponding values for the specific resistance, it is found that the metals arrange themselves into two groups, those in one class being paramagnetic, while the remainder are diamagnetic. The two curves which represent the results graphically are found to be such that the number of molecules per unit volume is proportional to the sixth root of the specific resistance for magnetic bodies, and inversely proportional to that quantity for diamagnetic ones. A comparison of the thermo-electric powers of the metals, with the corresponding molecular numbers, yields a similar result, the metals dividing into exactly the same groups, although the shape of the curves is somewhat different, and it is significant that a comparison of the magnetic coefficients, as far as our present knowledge of these quantities renders it possible, leads to the same grouping.

MANSFIELD, PA., is one of the latest towns in western Pennsylvania to operate a central station plant of electric lighting. The Westinghouse alternating current system has been installed.

THE NEW WESTINGHOUSE SLOW SPEED MULTIPOLAR RAILWAY MOTOR.

Our readers will recall to mind that in our issue of Oct. 15, 1890, we described the Westinghouse electric street railway motor which has since gone into successful operation on a number of railroads. This motor was of the usual two-pole high speed type, requiring double reduction gears. Since then the demand for slow speed motors which gear directly to the car axle has arisen, and in keeping with the progress of electric railway work, the Westinghouse Company has now brought out a new type of motor embodying slow speed, and gearing direct from the armature to the car axle.

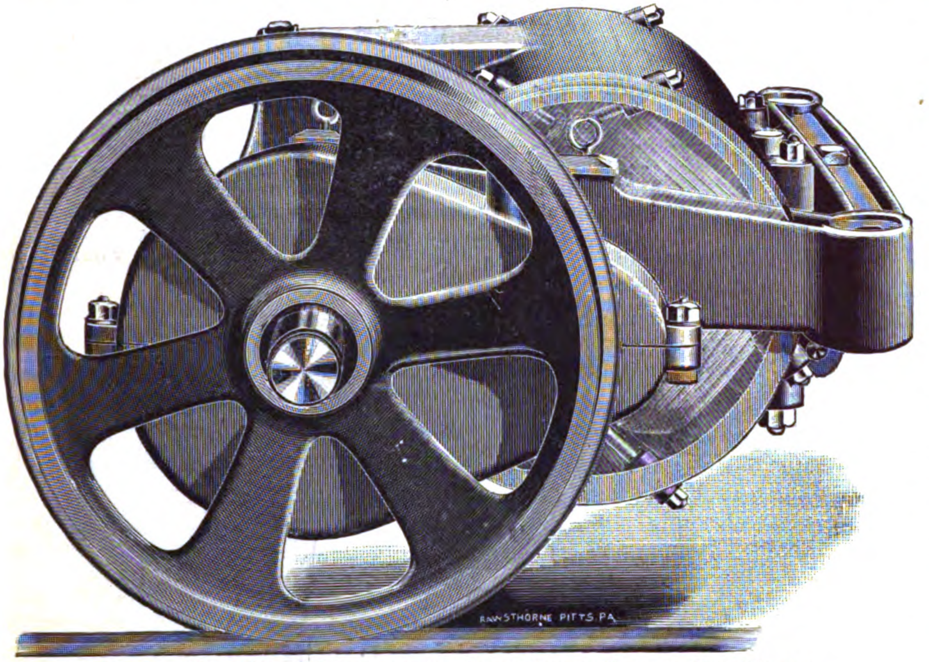

RAWSTHORNE PITTS PA.

Fig. 1.—The New Westinghouse Slow Speed Street Car Motor.

As will be seen in the accompanying engraving, Fig. 1, the general form of the motor is cylindrical, giving the maximum strength with a minimum amount of material, and thus reducing its weight. By eliminating sharp edges and corners, this form prevents the radiation of the lines of force, and consequent loss from external magnetism accompanied with a tendency to draw pieces of iron into the revolving armatures.

The machine, as will be seen in Fig. 2, is of the multipolar type, there being four poles. The field coils are composed of wire having exceedingly large carrying capacity, and by their low resistance adding to the efficiency of the motor. The field spools are thoroughly insulated, being as carefully wound as are machines designed to carry 1,000 or 2,000 volts. The core is of a specially soft grade of cast iron, having excellent magnetic properties. Again, the fields having narrow pole faces, reduce the reaction or demagnetizing effect of the armature on the field, and render the lead more constant, in turn reducing the liability to sparking at the commutator. Moreover, the poles being narrow, are magnetized with the least possible length of wire, which in turn offers less resistance and also increases the efficiency of the machine.

The armature is of the drum type, the core being built up of laminated grooved iron plates, so that the complete core has slots to receive the wiring. The wires being completely embedded below the surface, are not liable to injury from external causes and can have no lateral motion. They are covered above by strips of insulating material, and, when finished, the surface of the armature is perfectly smooth, so that the distance between the armature and faces of the field poles is reduced to a minimum, thereby greatly increasing the efficiency of the motor; and, should the journal bushings become worn so as to bring the surface of the armature core in contact with the fields, the wires, being below the surface, would not be injured. This method of winding is very simple, and repairs can be made by an ordinary workman. The peripheral speed of the armature is comparatively slow, as the wires move only 1,250 feet while the car passes over 1,000 feet, thus running at only about one-fourth the velocity of the high speed motor.

The commutator has been specially designed wholly for street car work, and so constructed that heating, should any occur, produces no unequal expansion, and obviates the tendency of the bars to become loose. Each bar or segment of the commutator has a bearing beneath, extending its entire length, rendering it impossible for a bar to become bent or moved out of place.

The brush holders are supported by a square oaken bar attached to the side of the frame, and are so clamped that they can be readily detached. The carbon brushes are placed in the sliding frame and press against the commutator by a pair of springs, which can be readily released for the purpose of removing the carbon and replacing it when it becomes worn. The brushes rest upon the upper part of the commutator, and, the greater part of the surface of the commutator being exposed above, it can be readily cleaned from the inside or from the outside of the car.

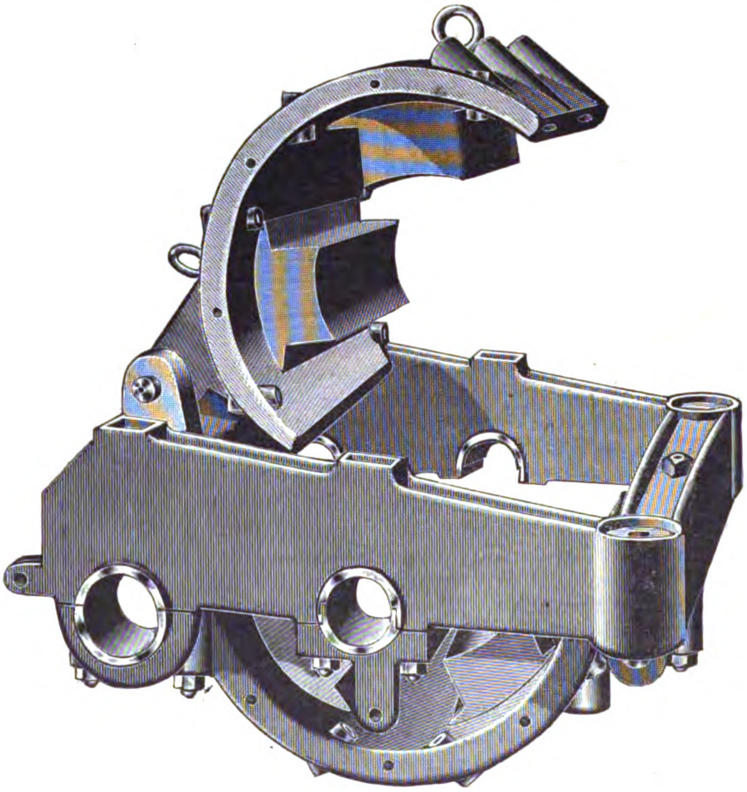
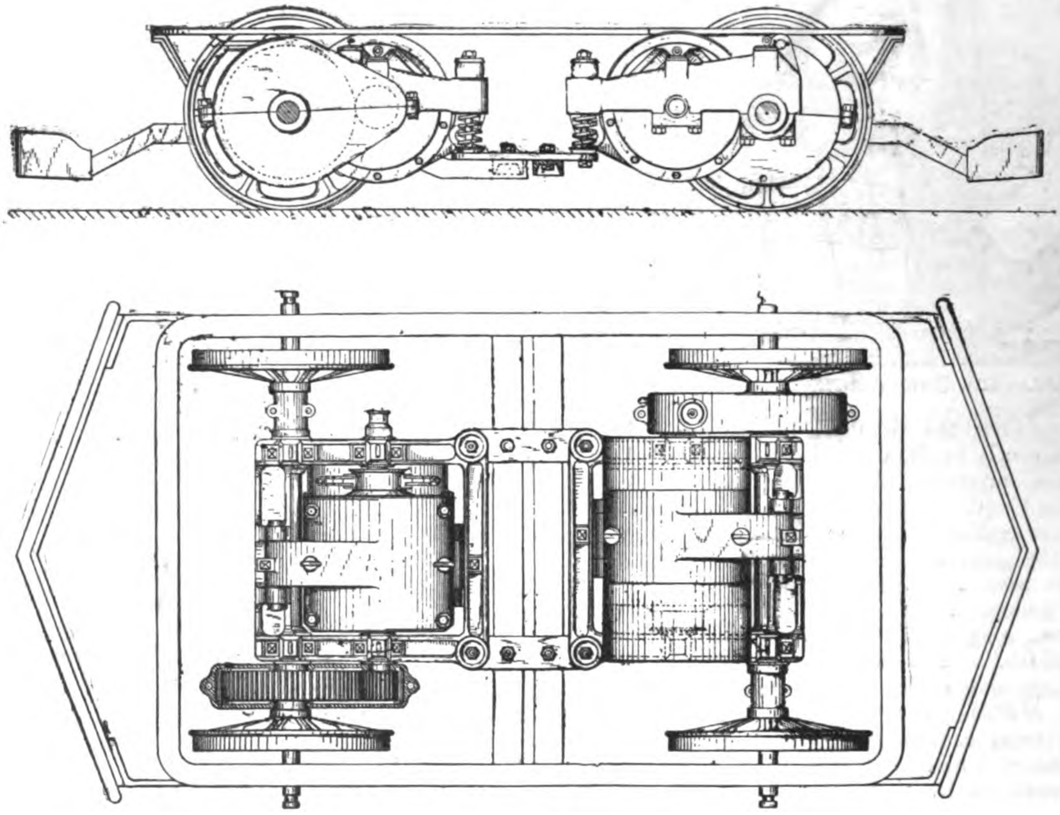


Fig. 2.—Westinghouse Street Car Motor Frame.

The cast iron frame on which the motor is mounted is rectangular, made in one casting, and is especially strong at points subject to the greatest strains. The frame being extended completely around the motor and suspended at both corners, the strains are distributed and the abnormal wear of the bearings is thus avoided. The frame maintains the armature and car axle always in perfect alignment, and produces a perfect meshing of the gears.

The field castings, as will be noted, are hinged and can be readily swung back, as shown in Fig. 2, thus giving easy access to the fields and armature. The lower field can be removed similarly to the upper by swinging back the lower semi-cylinder. Thus, it will be seen that any field can be removed without disturbing any other part of the motor. The armature can also be readily taken out and lowered into the pit by means of a sling, after the lower semi-cylinder has been swung back and the bushings removed, so that it is not necessary to remove the frame or body of the motor from the car truck when repairs to any one part are necessary.

The armature shaft is manufactured from the best forged steel, especially prepared, and the ends are tapered to receive the pinion which is fastened by means of a special tightening device. The advantage of this construction is that when the pinion becomes heated and expands, it is forced along the shaft, causing it always to maintain a tight fit, and also allows of its being readily removed and replaced.



Figs. 3 and 4.—Plan and Elevation of Westinghouse Motor on Truck.

The ratio of gear reduction is only 3.3 to 1. The gears are encased in cast iron housings partially filled with a lubricant. The housing prevents dust and dirt from getting into the gears, thus increasing their life and completely deadening the noise. The motor being almost entirely surrounded by iron, it is thoroughly protected, so that pans, sheet iron coverings, etc., are unnecessary. The field coils are not only protected from the outside, but from the inside by the heavy brass cap. By fastening plates on the sides by means of the holes shown in the sides of the semi-cylinders, the motor is completely shut in and thoroughly protected from rain and snow. The upper part is also shielded from water that may leak through the car floor or platform.

Figs. 3 and 4 show the motor mounted on a truck, one gear shown being encased and the other open.

THE "INFANCY" OF ELECTRICITY.

BY

John E. Sweet.

The following is a copy of a paragraph taken from an old publication, which, although the title page and date are gone from the book itself, must evidently have been printed in 1788 or 1789, as nothing in it appears to bear a later date. The work is evidently a cyclopedia of the sciences, with twenty of the large pages in text and two pages in fine steel engravings devoted to electricity:

> Since the time of this discovery, the prodigious number of electricians, experiments, and new facts have been daily produced from every corner of Europe, and other parts of the world, is almost incredible. Discoveries crowded upon discoveries; improvements upon improvements; and the science ever since that time went on with so rapid a course, and is now spreading so amazingly fast, that it seems as if the subject would be soon exhausted, and the electricians arrive at the end of their researches; but, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps equally, or more important than those already made.

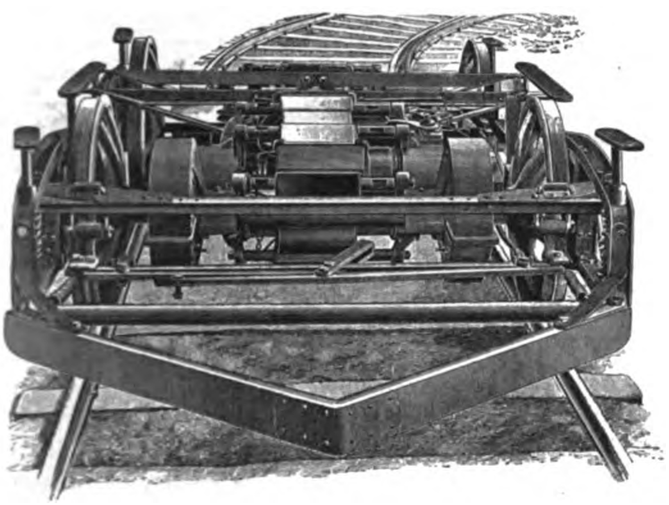
When one considers that what is said in this quotation was written probably 102 years ago, before what we now know as a battery was invented (although the word battery and electric light appears as familiar as in our present literature), the extract is highly interesting. Many other passages are about as interesting as the one quoted.

A HELMHOLTZ MEDAL.

Prof. Helmholtz will celebrate his seventieth birthday on August 31. In honor of the anniversary, a marble bust of Prof. Helmholtz will be prepared; and it is proposed that there shall be a Helmholtz Medal, to be bestowed on the most eminent German and foreign physicists. An international committee has been formed for the purpose of carrying out these schemes.

THE NEW BAXTER ELECTRIC STREET RAILWAY MOTOR.

In a recent issue we described the new slow speed, direct geared, street railway motor of the Baxter Electric Motor Co., and are now enabled to present an end view of the motor and truck. The eight-pole motor employed has a Gramme ring armature which revolves at a speed of 420 revolutions per minute when the car is running at a speed of ten miles an hour. As will be seen, the gears and pinions are enclosed in a dust and air-tight casing that is partially filled with oil, which reduces the wear to a minimum, practically renders them noiseless, and at the same time affords perfect lubrication, not only to the gears but to all bearings. This casing is virtually the frame of the motor and adds little to its dimensions or weight. To increase the efficiency of the motors and avoid torsional strains and tendency to side play, a pinion is placed on either end of the armature shaft, each meshing with a gear on the axle. The space on the shaft left available by the use of the Gramme ring armature allows of the use of the two pinions without crowding the armature. To prevent any binding in the bearings while taking curves the motors are suspended upon a universal joint. Owing to the compactness of the motors, ample space is left in the wheel base for a frame work or cradle, spring supported from the truck, which carries the resistance box, and to which the motor suspension is attached. Another important feature is the ample clearance, namely, six inches, between the lowest part of the machinery and the pavement. Both brushes are placed at the top of the commutator, so that by removing the trap door in the floor of the car they can be readily gotten at. The car is governed by a single crank lever under the control of the driver, the car going ahead or reversing in the same direction as the movement of the crank lever and the speed being exactly in proportion to the distance through which the crank is turned.



BAXTER SLOW SPEED MULTIPOLAR STREET CAR MOTOR.

HOUSETOP WIRES IN NEW YORK.

At the last meeting of the Board of Electrical Control, the Mayor introduced three important resolutions. The first requires the Subway Company to build subways where needed in all the streets to be repaved before the new pavement is laid. This is to prevent the tearing up of the pavement after it is once down.

A second resolution requires the removal of all housetop wires in districts where there are subways, within thirty days. After that time the wires will be cut down by the Department of Public Works.

The third resolution requires the removal from the streets before June 1, of all electric wires and poles in that part of the city bounded by Third and Eighth avenues, Eighth and Fifty-ninth streets, as the Mayor claims that there are sufficient subways now in that district to accommodate all the wires. After June 1, the remaining poles and wires will be taken down by the Bureau of Encumbrances.

NOTE ON THE INTENSITY OF TELEPHONIC EFFECTS.[1]

BY E. MERCADIER.

The intensity of telephonic effects depends chiefly upon the thickness of the diaphragm, its diameter, the intensity of the magnetic field, the form of this field and the induction coils.

The influence of the thickness of the diaphragm has already been investigated (vide *Comptes Rendus*, April 5th and 8th, 1889), and it has been shown that, for every telephone of a given magnetic field, there is a certain thickness of diaphragm which gives a maximum intensity.

This thickness having been found, it remains to be determined what diameter gives the best effect. The magnetic field of the core only produces a sensible effect within a limited region of the diaphragm, which is not increased by an increase of area. Such an increase, it is true, adds to the flexibility, and favors the vibration of the diaphragm, but, on the other hand, its mass is increased, and therefore more difficulty is encountered in producing these vibrations. Hence, the best diameter will vary with the intensity of the magnetic field, and, therefore, it is necessary to combine the proper thickness with the proper diameter, according to the intensity of the field at disposal. The influence of the field, however, is far from being as great as might be supposed at first sight.

Very varied experiments have been made on this subject in magnetizing the cores of soft iron of the induction coils by means of an electro-magnet, instead of fixing them, as is commonly done, at the poles of a magnet. It is thus easy to produce magnetic fields of very different intensities, by causing the current which excites the electro-magnet to vary in intensity. By working in this way it is easy to arrive at a certain limit at which the effect of the telephone does not vary sensibly, this limit being reached when the mass of the iron becomes rapidly incapable, as it were, of absorbing all the lines of force of the field, and more and more of these lines traverse the diaphragm.

This can be tested by scattering some fine iron filings upon the diaphragm, and observing that an increasing portion of the field becomes useless in the production of telephonic effects.

It is necessary, further, to observe that these effects are due to the deformations of the lines of force of the field; that these resist the deformation due to the energy of the waves arising from the voice, according as the magnetic field is more intense, and that this energy is necessarily limited. These remarks apply equally well to the telephone receiver.

It is evident that, other things being equal, the best form of field is that in which the lines of force are perpendicular to the direction of the wire in the coils. Moreover, the variations in the form of the field may be facilitated by the mobility of the field, and this can be increased up to a certain point by the mobility of the magnet and of the cores of the coils.

In summing up the foregoing facts, it seems that the following conditions are those by means of which it is possible to obtain the best results from a telephone, namely:

1. The mobility of the lines of force of the field should be favored.
2. The lines of force should be cut by the greatest possible turns of wire of the coils, and perpendicularly to their direction.
3. The thickness of the diaphragm should be diminished until it is just sufficient to absorb the greatest number of lines of force existing in its vicinity.
4. The ratio of that part of the diaphragm which comes under the influence of induction to the whole of the diaphragm should be increased.

NEW YORK SUBWAYS.

A bill has been introduced in the State Senate by Senator Roesch, of Tammany, which seeks to legalize the transfer by the Consolidated Subway Company of those of its subway conduits that are used for telephone, telegraph, and other low-tension wires to the Empire City Subway Company.

"EL EXPORTADOR AMERICANO."—This excellent and well-known trade export journal has established an electrical department, which it has placed in charge of Mr. W. H. Fleming, a well-known electrical engineer, thoroughly familiar with the Spanish market, and its electrical needs. We hope he will be able to do a great deal in opening up the trade that is undoubtedly awaiting for electrical concerns in South and Central America and the West Indies. We note an item in the paper quoting from THE ELECTRICAL ENGINEER, which it speaks of as "El principal periodico publicado en los Estados Unidos, sobre asuntos electricos y que es considerado como la mejor autoridad, en la materia." For which gracious compliment we can only say "Muchas gracias, Senor."

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[1] *Comptes Rendus.*

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XI. NEW YORK, MARCH 4, 1891. No. 148.

An observer states that there is not a plant in existence having a sufficient capacity to supply one-twentieth of the demand for light and power that now exists within practical working limits of its area of distribution.—Marsden J. Perry.

RAPID TRANSIT PROBLEMS IN GREAT CITIES.

THERE are many problems that call for settlement in modern cities, but none are more important than those which relate to rapid transit. The questions touch not only the welfare of all who have to live among large populations, but of all who visit these cities on business or pleasure. They affect more particularly our newer American cities that so often grow at an astounding rate and spread over enormous areas, the percentage of increase and the extent of ground covered being entirely without precedent in the development of urban centres of Europe.

Many solutions have been offered and tried of the rapid transit problem, but it remains, and will not down. If no new departure be taken, the difficulties of city life and city government will intensify and the end will be serious and complete disorganization. It is not easy to sum up the discomfort, loss and derangement of household and business affairs caused in New York by even a slight and trivial interruption of the schedule on the elevated roads. Yet surely by this time, some plan ought to have been hit upon, aided by modern ingenuity and invention, that would render locomotion sure, safe and speedy from one boundary of the city to the other, at any hour of the day or night, in any weather, at any season of the year.

Have we reached any such point or plan? This was the topic brought before the Electric Club at its dinner last week, and, in passing, we may congratulate the club on its endeavor to deal thus with the large issues affecting the public weal. Electricity to-day leaves few provinces untouched, and there is much good work to be done in making clear the new conditions and relations it will establish. To those whose daily work lies in the development of electrical industries, every sunrise brings its fresh surprise as to the unforeseen, far reach of the new agency and art; and if it be thus with men who are keenly watching each step forward and surmising actively as to each coming opportunity, how must it be with a public to which the nomenclature and the principles are alike mysterious and esoteric? The club can prove inestimably useful as a means of enlightenment and as a platform for the free and impartial treatment of these broad topics.

The right of electricians and electrical engineers to take special interest in the rapid transit problems of great cities was well justified last Thursday, in the series of interesting letters and speeches that followed the dinner. The floor was an open one, the most diverse and opposite methods were given the chance of advocacy, and the result was a wonderfully good all round handling of the subject by experts and specialists of deserved reputation. Such a discussion could not but be of benefit, even if it but added to the information of those present; but the fact is that, without exception, every city in this country is feeling a special interest and anxiety as to the matter and is looking for advice and suggestion.

The summing up of the discussion, of which a very full report will be found in our columns this week, must be of great encouragement to the electrical engineer, for to him evidently the great majority are looking for rapid transit facilities worthy of the name. Just what those facilities shall be is determinable largely, if not wholly, by the size and peculiar circumstances of each city, but the flexibility of electrical transmission is so great that if one method will not answer, others will. For a city of the magnitude and shape of New York, the need seems to be, and is, an underground electric road clear around the city; and the exact situation here was defined by Mr. Sprague. As a further most important contribution to the rapid transit discussion, we have also printed this week Mr. Sprague's interview in the *Commercial Advertiser*, now published with authority, and accurately, for the first time in a technical paper. If our readers will read carefully this interview and the report of the dinner at the club, they will be well and fully informed on this vital question of the hour.

ELECTRIC RAILWAY WORK.

THE uninterrupted work of improvement which is going on in electric railroading is well demonstrated by glancing through our pages this week, in which we describe no less than three different forms of slow speed, direct connected motors for connecting the armature to the car axle. We think there can be no doubt as to the superiority of the single reduction gear over the double reduction driven by the high speed motor; and while the latter has done, and is doing, good service, it seems now only to be a question of time when it will be displaced by the new type. The next evolution will be no gear at all. It was no doubt this fact which Mr. F. H. Monks, general manager of the West

End Road, of Boston, had in mind, when he spoke of the caution and reserve necessary in extending electricity on the lines of his company, notwithstanding the urgent demand of the citizens for electric rapid transit. His hint was also pertinent, that our climatic conditions are such that it might be found more desirable to employ independent electric locomotives in preference to cars, each individually equipped with its own motive power.

NATIONAL WIRING RULES.

While the requirements demanded by the fire underwriters have done much to raise the standard of electric wiring work, there unfortunately still remains much to be effected in this direction. The rules thus far laid down by the various bodies of underwriters, while all tending to secure good work, vary more or less from one another, and this, we think, is a serious drawback to their general adoption. We feel convinced that a standard set of rules, issued by the proper authority, and sanctioned by the various boards of fire underwriters, will meet with general acceptance among electrical engineers, and will be hailed with delight by many who are now at a loss which rules to follow. The National Electric Light Association is preeminently the body from which such a set of rules ought to emanate, and we hope the committee appointed for that purpose will be able to report in full at the next meeting of the Association.

THE "INFANCY" OF ELECTRICITY.

The characterizing of the present state of the art of electricity as the period of its infancy so often greets our ears, that it is time to call attention once more to the fact that, far from being in its adolescence, electricity is a science which attracted a large share of attention even in the last century. Indeed, those who will take the trouble to look up the subject will find the electrical literature of the last century by no means a small one. As bearing on this point, Prof. John E. Sweet sends us an interesting communication containing an extract from a work published apparently in the last century. Strangely enough, it was thought, even at that time, that the end had been reached, and little hope was held out that further advances would be made in this branch of science. And yet, with this statement before us, who can say that the progress which will have been made a hundred years hence will not be such as to justify the calling of this, the infant age of electricity? The passage cited by Prof. Sweet is not familiar to us but reminds us very much of the utterance of Dr. Priestley, when he held that in electricity the *ne plus ultra* would never be reached.

STORAGE BATTERY CONSTRUCTION.

The variety of forms which the storage battery has taken in order to overcome the difficulties in its management and operation for long continued periods, has often been commented on; but we think we can discern novelty in the more recent forms which have been brought out. It is evidently of paramount importance that, in order to obtain uniformity of action—the lack of which is the cause of most of the troubles experienced in the past—the electrolyte and current must be able to act equally upon every part of the active material. The recent experiments of Prof. Ayrton show in a most striking manner the inequality of the action in the forms now in general use. In consequence, we see the more recent storage batteries designed with special reference to avoid this. An interesting departure in this direction is the storage battery plate due to Mr. S. C. C. Currie, which is described in another column. By the employment of an asbestos sleeve surrounding the active material, which in turn completely covers the lead of the grid, the current is obliged to pass entirely and uniformly through the active material. The tests which have already been made of cells built on this plan, certainly show remarkable results and demonstrate not only its lasting qualities, but its capability of withstanding very heavy charges and discharges without deterioration, a quality which makes it specially valuable for street railway work.

Mechanical Vacuum Pumps for Incandescent Lamps.

The manufacture of incandescent lamps on a large scale has, perhaps, done more than any industry to develop apparatus for obtaining high vacua. That the very life and efficiency of such lamps depends upon the degree and integrity of the vacuum has been so often demonstrated, that no trouble has been spared to secure this first desideratum, and the mercury pump has, up to the present day, been looked upon as the only available means for the satisfactory exhaustion of incandescent lamps. It is true that mechanical pumps have been employed to effect initial exhaustion, but the final work has, up to the present, always been accomplished by the mercury pump. The comparatively large item of expense involved in the production of the vacuum by the mercury pump seems therefore to make it eminently desirable to find, if possible, a substitute for this expensive and tedious process. Our readers will therefore be interested in the description we give elsewhere of the Beacon mechanical vacuum pump.

The Protection of Long Circuits.

The frequent interruptions of telegraph service between the large cities this winter has led to a discussion of the subject in some of the daily papers. The writers cannot see why measures are not resorted to which shall render the wires less liable to breakage than they now are. The question has been taken up by Mr. John C. Wilson, the electrical engineer, now of Boston, who, in a letter to the *Herald* of that city, says that "in no department of electrical mechanics has so little improvement or advancement been made as in the erection of lines of telegraph." To prevent these interruptions, Mr. Wilson proposes that the wires between cities should be carried along the lines of railway in light and strong aerial tunnels of glass, iron or steel, "to the inside of which the wires could be readily attached far enough apart to prevent serious inductive interference." This plan is practically the same as that proposed for city wires by Mr. A. A. Knudson, who not long ago devised an aerial conduit to hold all the wires, and to be carried along the streets on poles. Mr. Wilson believes that his cross country aerial tunnel could be made strong enough to withstand any storm. That, of course, is the main point; and the subject is one that he would do well to follow up.

AN INTERVIEW WITH MR. SPRAGUE ON UNDERGROUND ELECTRIC RAPID TRANSIT FOR N. Y.[1]

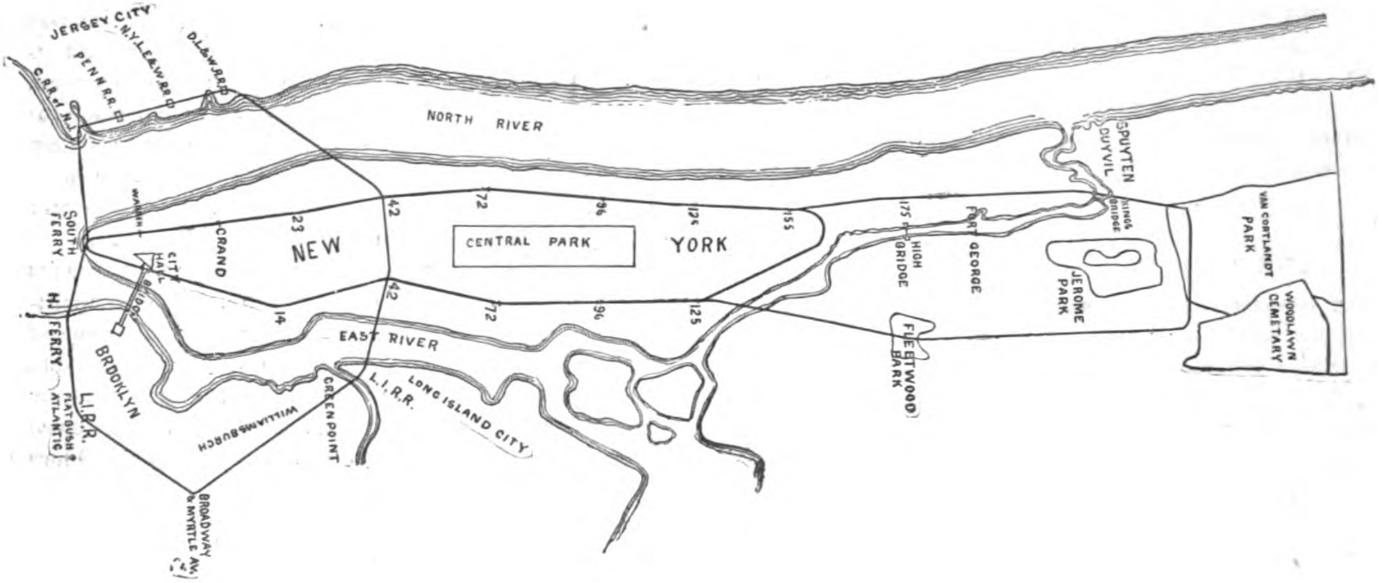
BY GEORGE HELI GUY.

MR. SPRAGUE, on being asked to give his views on the general aspect of the rapid transit question, said:—

For two years or more the question of rapid transit has easily held its position as the foremost subject demanding the immediate attention of New York. The urgent need of the city for some great improvement in its methods of communication, the eager discussion of the subject on every hand, the demand of the people as voiced by the press, by petition and by representatives, have finally made themselves felt, and we have a rapid transit bill and a commission empowered to give the necessary relief. And well it is, for New York has always been behindhand in providing for its needs.

The total annual passenger traffic—that is, the total number of persons carried in this city—has increased at the rate of over 140 per cent. in each period of ten years since 1866, and is now something over 325,000,000. At the same rate of increase it would amount in 1890 to over 500,000,000, and in 1900 to 1,255,000,000.

Rapid transit is indeed urgent, but no less important is the proper solution of a plan which shall not only meet the needs of the New York of to-day, but that greater New York to which it is our pride to look forward. The decision of the plans of such a road should be based on the broadest conception, not only of the territorial growth of the city and its surroundings, but with due regard to the changes which shall take place, when narrow streets shall give way to broad ones, when obstructions shall disappear, when permanent and perfect pavements shall be the rule, not the exception, when residences shall be replaced by business blocks, and when the most daring conceptions of architects and builders shall reach their fruition; when we shall point with pride and confidence to every municipal work.



MR. SPRAGUE'S PROPOSED SYSTEM OF RAPID TRANSIT FOR NEW YORK AND VICINITY.

To effect this would you advocate the building of the line simply on its own basis, or with regard to existing lines and outside connections?

It should be planned first of all to meet the requirements of New York city, the wants of the business and the laboring man, for women and children, for resident and visitor; to make communication as easy and as rapid as possible, not only between the residential and the business quarters of the city, but between the city and its suburbs, when such there shall be, and between the different parts of the business districts and the different parts of the residential districts; for social as well as business demands; in short, to get the most intimate communication between all parts of this city.

Such a road should not only be built in the most substantial manner, but with well-hedged privileges and franchises, which, while protecting the city in its undoubted rights, should offer the certainty of fair and equitable returns to an investor, large or small, so that its bonds and stock should be as safe and as much sought after as a government bond.

Whatever the demands of our neighbors, whatever the plans suggested for our consideration, it must not be forgotten that New York wants rapid and convenient transit now and all the time, day and night, and that of every hundred passengers on the elevated or surface roads, ninety-nine have no call to go out of New York, and are solely concerned with the best means of following their daily vocations without unnecessary loss of time.

I am not unmindful of the desirability of easy communication between New York and Brooklyn, or Long Island City, or Hoboken or Jersey City, nor the value of every connecting link commercially possible between the great trunk lines which have done so much to build up New York; but consideration of this demand should not subordinate the real issue which is before us to-day, which is: How quickest and best can the inhabitants of one part of this city get to any other part of it? The needs of New York must predominate, not the needs of its neighbors, which can properly be taken care of without sacrifice.

On what other important grounds do you advance such a view of the case?

That we may fully realize the demands of New York, it should be considered geographically. Since the annexed districts have been added, the general contour is very much like that of the stock of a fowling piece, with the breech at the Yonkers line, that is, the upper boundary of the Twenty-fourth district, the trigger-guard coming in the Twenty-third district on the east side, almost in line with the 155th street station of the elevated railroad, and the barrel end at the Battery, sixteen miles away. From the Battery to the Grand Central depot is a trifle over four miles. It is seven and a half miles to the upper end of the park, eight and a quarter to 125th street, and nine miles to the Harlem river, on the centre line of the city. Jerome Park is as far from the upper boundary as are the Bowery and Cooper Union from the Battery. One Hundred and Twenty-fifth street is the centre of New York, Central Park being entirely within the lower half. The Forty-second street depot being only one-quarter of the distance up, will, in a not very distant future, be "down town." Before 1900 its present function as a great passenger station for trunk lines will disappear, and these functions will be supplied by a larger and more magnificent depot, further north, reached by rapid transit lines.

More than one-half of the area of New York is above 125th street. With this great length, however, New York is limited by its water fronts. It attains a width of two miles at Grand street, a mile and a half from the Battery. It has the same width at Forty-second and 125th streets, and in all this stretch, its widest portion is at Fourteenth street, where it is two and a half miles. Its greatest width, four and three-quarter miles, and for a short distance only, is at about one-fourth of the length of the twenty-third district, that is, on a line through 125th street. The length of New York, then, is about six times its mean width. Brooklyn, including Williamsburg, Jersey City and Hoboken, are all opposite the lower quarter of New York, and Long Island City is opposite the second quarter.

It would seem from these facts and the wonderfully rapid extension and growth of the city in its upper section that the making of the rapid transit plan of New York depended upon the wishes or needs of our neighbors, or if the advocates of a greater municipality prefer to put it so, making the plans of the Manhattan section of New York city dependent upon the needs of its eastern and western districts, would be the height of folly.

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[1] *New York Commercial Advertiser*, Feb. 16, 1891.

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These districts can be well and properly served, when we consider their geographical situation, by properly constructed connecting links running under the East and North rivers, which links shall be designated for that purpose alone, and not necessarily as limiting integral parts of the city system proper.

Will you briefly give your ideas as to the more prominent plans which have engaged more or less seriously the attention of capitalists and the public, of which there are no less than fourteen?

Well, if we begin with the Beach pneumatic system, that was merged into the Broadway Underground, and this in turn into the New York Arcade Railway Company, and it is now familiarly known as the "Arcade." Its advocates proposed to run from the Battery, thence to Broadway and Madison square, with four tracks, the two centre being express tracks, with stations one mile apart, and the two outer tracks for way traffic. Thence the route extends to Fifty-ninth street by Broadway, and to the Harlem river by Madison avenue, with an additional route up the west side of Central Park by the Boulevard or some other avenue and into the annexed district. Branches are proposed to connect Broadway and Madison avenue on Twenty-third street, and the two branch roads on Forty-second street.

The Underground Railway Construction Company has pooled the issues of the New York District, New York Underground, and the Metropolitan Junction Company. The route of the first is similar to that of the Arcade, and runs from the Battery to Broadway and Madison square with four tracks; thence up Broadway to Fifty-ninth street, and up Madison avenue over the Harlem river to some point near Jerome Park. Branches are also proposed from river to river on Twelfth and Twenty-third streets. The New York Underground road proposes to run from the City Hall park east to Broadway, through Centre and Mulberry streets to Lafayette place and Fourth avenue, at Union square; thence by two lines to the Grand Central, and Broadway and Fifty-ninth street, up the Boulevard to Kingsbridge, the main line continuing under Madison avenue to the Harlem river, and by a loop to Kingsbridge.

The Metropolitan Junction Company promises to connect with the two last named in the annexed districts, and then run over the Hudson by a bridge at Washington Heights, connectingwith a tunnel through the Palisades.

The City Railway Company proposes to begin at South and Whitehall streets, crossing Broadway below Rector, running between Church street and College place, Sixth and Seventh avenues to Fifty-ninth street and the Boulevard. The line would then run up the west side of Central Park, crossing the Harlem River above High Bridge, terminating in New Rochelle. Branches are proposed for the principal ferries on both rivers, the Post Office and Grand Central station. The roadway is intended to be fifty feet wide and twelve feet below the surface; it is to have four tracks, two way and two express. It differs from the other underground railways in that, instead of taking the street lines, it proposes to purchase the necessary property and erect buildings over the line of the road, which are to be rented for sufficient to pay the bonds of the company. The road thus running through the basements, so to speak, of the buildings and crossing the streets by tunnels, becomes a covered roadway instead of an open one.

The Terminal Underground Railway Company proposes a four-track underground railway from the City Hall along the proposed Elm street improvement to the Grand Central depot.

The Metropolitan Transit Company proposes two elevated steel structures, one on Broadway, between Chambers street and Forty-third street, connecting with the Grand Central depot, and the other on the west side following the line of the water front to Gansevoort market, thence up Tenth avenue and the Boulevard to Kingsbridge.

What about Mr. Heman Clark's plan?

Mr. Clark's plan is one of the most radical. He proposes a four-track tunnel, beginning near Fleetwood Park, cut in solid rock 150 feet below the surface, coming down about 100 feet west of the line of Broadway to the Astor House, where it would connect with two two-track branches, one going under the North River to Jersey City and Newark, and the other under the East River to Brooklyn and Prospect Park. Passenger stations would be at the foot of shafts sunk every two miles, and freight stations at intermediate shafts, where freight pockets would be tunneled. Large elevators would be used for handling the passengers and freight.

Then there is Austin Corbin's scheme?

Yes, one of the latest plans is that of the Metropolitan Underground Railway Company, at the head of which is Mr. Corbin. The primary object of this company is apparently to make a connection from the trunk line railroads centered in Jersey City with the Long Island system, by tunnel under the East and North rivers, with connections for the New York city systems at Whitehall street near the Battery. It is proposed as a subsequent proceeding to run four other sections, all double track, taking in the east and west sides of New York, and forming a loop around Jerome Park. The tunnel passing through solid rock its entire length, would be over 100 feet below the curb of Broadway. Stations are common to both tracks, and would be reached by elevators of large carrying capacity. Electricity is proposed as a motive power, each car to have its own motor, and a speed of thirty miles an hour to be attained. However well this scheme has been worked out, its main object is primarily for the purpose of connecting the trunk line systems of Jersey City with the Long Island railroad system, with New York as a sort of way station, and rapid transit in New York city as a secondary consideration, to be provided in some remote future after the carrying out of the initial project has been accomplished. As a matter of fact, the results proposed are contradictory, because no double track railroad operated with single car units, or, for that matter, train units of any number of cars, can by any possibility give rapid transit to New York, even to-day, much less when the road would be completed. New York cannot, and will not, make its rapid transit plans subservient to, or dependent upon, trunk line transportation, north, east, south or west, or upon the requirements of trans-Atlantic travelers.

Yet another scheme affecting New York is that of the New York and New Jersey Terminal Company, which proposes an underground railway starting from near Newark, where it is to make junction with the Pennsylvania, the Delaware, Lackawanna and Western, the New Jersey Central, the Lehigh Valley and the Erie roads; thence running under the Hackensack river to Hoboken, and thence to the western end of Fourteenth street, New York, where the tunnel would be divided, one branch running to the Wall street section of the city, and the other to a main terminal station at Union Square. Other stations would be provided for both freight and passenger service. Electricity is proposed as the motive power. While this seems a very practical scheme for making connection with the west and south bound trunk lines, it is not rapid transit for New York city.

Various other plans have been suggested, but it will be unnecessary to discuss them, but to confine ourselves to a consideration of the only one that ever came to fruition, the elevated system, and such other system as will best meet the wants of New York city.

A very inviting bill of fare, Mr. Sprague, but what do you think of the crust we now have?

The elevated system is of comparatively recent birth. It started with Harvey's elevated cable road, in 1868, which two years later was converted into a steam road and now forms the Ninth avenue division. The Third, Sixth and Second avenue railroads soon followed, and all were later consolidated into the Manhattan system, now operating many miles of double track, with an equipment of about 850 cars and 190 locomotives, and carrying about 500,000 passengers daily.

Before outlining what I think is the only proper system for New York, it is desirable to consider briefly what opportunity the Manhattan system offers for a solution of the question asked: "Can this system be made available for the best rapid transit, and if not, what can be done to improve its service?" It labors under three great disadvantages. It is a double track system, it has no loop connections, and it is necessarily limited in speed.

Its service could be somewhat improved if, as is suggested, a connection should be built along the southern bank of the Harlem river, between the Second, Third and Eighth avenue divisions, the Y connection at the South Ferry station be abolished, and property enough purchased for loop and storage tracks, so that trains could be operated in a continuous loop in both directions around the city. This would prevent some of the blocking and tedious delays which the present system of despatching entails, but it would not give rapid transit.

A thorough connection by the Second avenue line with the Harlem River and Port Chester and the Suburban Rapid Transit roads would be of benefit to the people along these routes, but they would not have rapid transit. The addition of a third track with the necessary reconstruction or stiffening of the present structure would give faster time down in the morning, and faster time up at night, but this would only be a makeshift, and would not meet the requirements of rapid transit.

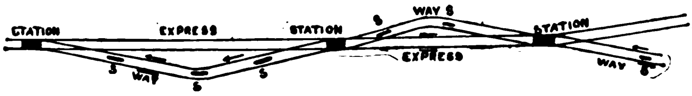
Not even on the double deck plan?

A double story, four-track system, such as has been proposed, should not for one moment be tolerated. I would not disparage the good which has been done by the elevated roads, because New York owes, in a very large measure, her prosperity and growth to them; but this should not make us blind to the inefficiency of this system to meet the wants of to-day and the future, and it should be remembered that, when the elevated roads were built, no such system of tunneling and locomotion as I shall outline was possible.

The replacing of steam by electricity, which could be done at a moderate expense, would do away with many of the objectionable features of the present system, but still we would not have rapid transit, and rapid transit is the living, crying need of New York to-day.

What is your idea of the plan best fitted to meet the requirements of the city?

To my mind no one of the foregoing plans can prove wholly satisfactory, and the plan I favor is: An independent way and express service, each having double tracks, but having independent paths, run in independent circular iron tunnels, and forming a loop around the city from the Battery to Jerome Park. The express and way routes to intersect or join at different levels at common stations, the trains to be operated by electricity. Way tracks to have stations about every third of a mile, express every mile and a half. A loop to be provided just south of the Harlem river. There would also be a cross-town two-track system running beneath the city division, intersecting it on the east and west sides on the Forty-second street line and at the Battery, and making connection with the Long Island, Broadway and Atlantic avenue station on the east, and the trunk line depots on the west.



Express and Way Routes.

This sketch I have here shows the city express line, but not the way line.

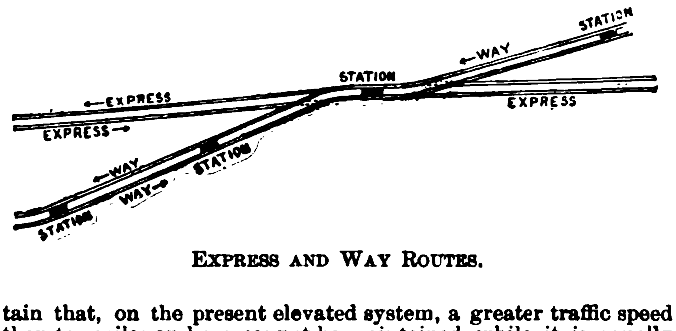
What are the considerations that make this general plan the best?

Independence of express and way service is essential. The operation of express and way trains on a two-track railroad, to meet the condition of service of New York city, should not be thought of. It is impossible to satisfactorily so operate to-day; it will be vastly more so twenty years from now. A moment's consideration of the essentials of way and express service, both in the matter of carrying passengers, making high speed, running at short intervals, handling heavy trains, economical use of power, and allowable capacity of engines will show this.

To illustrate this point, we have only to consider the work done on the Third avenue elevated road, such as it was a short time ago, and it cannot be less to-day. I have made a special study of it for several years.

This road is eight and a half miles long. Grades vary from 8 to 105 feet to the mile. The level stretches amount to about one-third of the whole distance, and this includes the stations. On the seventeen miles of single track there are fifty-two stations. In the busy hours there are no less than sixty-three four and five-car trains on the tracks. These trains, weighing from eighty to ninety-five tons, make the half trip in forty-two minutes, including stopping at twenty-six stations and discharging and taking on passengers, or at the rate of about ten traffic miles per hour. The work of the engines may be divided into three parts, overcoming the train's inertia, lifting the train on the grades, and traction, and the maximum is at least seven times that necessary for traction at mean speed on a level. Three times in every mile this weight of eighty to ninety-five tons must be started from a dead rest, raised to a speed of twenty or more miles an hour and brought to rest in about eighty seconds. The engines are run with 130 pounds boiler pressure and have a capacity of 185 h. p. Fifty-nine per cent. of the power on a round trip is used in accelerating speed, 24 per cent. in lifting and 17 per cent. in traction, and the average power developed per minute per round trip, including stoppages, is 70.8 h. p.

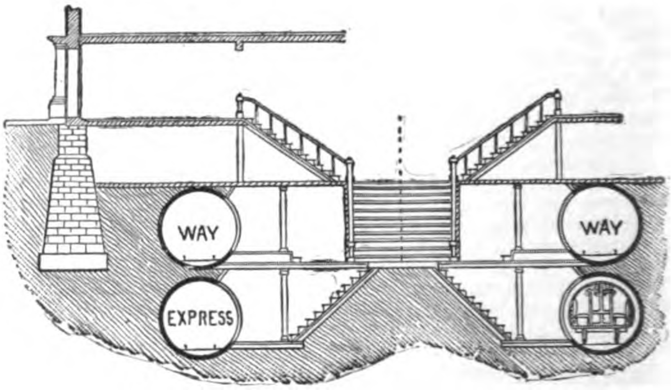
These are instructive figures, which alone should show the fallacy of a two-track system. They show that it is perfectly certain that, on the present elevated system, a greater traffic speed than ten miles an hour cannot be maintained, while it is equally true, on the other hand, that we cannot consider any less frequent stations for way service than three to a mile, yet note what tremendous duty is required of engines to make even this moderate speed under conditions of frequent stops. Under the conditions here given on such portions of the road as are fairly straight and with easy grades, a maximum speed of about twenty-two miles an hour must be attained, but on a road like the Sixth avenue and Harlem division, where there are many sharp curves and grades as high as 2 per cent. the maximum speed must rise as high as twenty-eight miles an hour to make the schedule time, and this speed can only be attained on a fairly long stretch as between the Fifty-ninth and Seventy-second street stations. Ten miles an hour is slow enough way speed; it ought to be fifteen at least, which, under excellent conditions, that is, on a road free from disadvantageously situated grades and with no sharp curves, would require a maximum speed of about thirty-three miles an hour. With a long stretch between stations, the average speed is very much nearer the maximum, and the same motive power which will handle a way train on short intervals, will handle an express train at longer intervals easily at double the mean speed, say, thirty miles an hour, with a maximum of forty miles. Therefore express trains ought to stop only about once in a mile and a half, or say every fifth way station. It should be noted that on an express train, stopping at few stations, not only would much less time be spent in getting under way and stopping, but also at rest at stations taking on and discharging passengers, so that I am well within bounds when I say that a motor which can do the service of a way train at short intervals, can equally well do the work of a heavy express train at long intervals.



Express and Way Routes.

Do we need to stick to daylight travel and the use of New York city as a big sounding board?

That a rapid transit road should be built below the surface seems apparent, and the use of electricity as motive power, the modern systems of tunneling, and the perfection to which elevator service has attained, should make the advantages of an underground system clear and its success unquestionable. Any four-track system if run above ground must almost of necessity be run over a common route. If it follows the street it is impossible to get the room for four tracks, unless one set of tracks is placed above the other. The road must be largely dependent upon street grades and street curves. If cut through blocks so as to get more room and direct lines, the cost of the property condemned, and the investment necessary, would be enormous, and there would still remain the objection of crossing streets every 250 feet. Furthermore, any surface or elevated system is exposed to weather obstructions, whether in the form of a fog, which necessitates slow and cautious running, or ice and snow, which impede the way and increase the slip of the motor. An elevated structure, except when very massively built, cannot have the same rigidity that a tunnel structure has. There is always the danger of derailment, a tumble into the street, and a greater liability of train collision. If an individual tunnel construction be used, there would not only be no room for a train to fall, but a broken axle or a derailed train would not, of itself, be apt to prove serious. The tunnels would be lighted constantly and uniformly, the rails would be always in perfect condition for adhesion, of almost constant length, and the temperature of the tunnel would be almost constant. Heating of the trains or stations would be unnecessary. Ventilation could be made perfect.



Express and Way Stations.

But we shall miss our flitting glimpses of second-story scenery?

Cars for such underground system would require no windows, landscape views not being essential to rapid transit in a city, and hence can be as strongly constructed, with less weight. Absolute freedom from sharp curves, and the arranging of grades so that instead of being a detriment, they can be of positive aid in train service, are not among the least advantages of an underground system. Where curves occur, they can be either on a dead level or the grades can be so managed that they will be of service.

Would you have one large tunnel or a number of tunnels?

Having determined upon a tunnel construction, independence of express and way tracks is not all that is essential. These might be obtained if all four tracks were in a common tunnel, but when we realize some of the other conditions which must be met, and that such a four-track system could not be placed in a common tunnel less then fifty feet in width and twenty feet in height, if tracks are all on one level, or about twenty-five feet wide and high if double-banked, objections to such construction are pronounced. It is manifest, also, that if the size of a tunnel for four tracks has objections structurally and otherwise, one for two tracks must have similar objections, although in a less degree. Hence my plan is a system of independent express and way routes, each having two tracks, each carried in independent tunnels, and having their paths intersect at certain common important points, say on an average every mile and a half. I would have not only the routes of these services independent of each other, save at their common meeting points, but I would have them at all other points independent also in the matter of grade, and furthermore. I should have the tunnels of each system, while normally running side by side, sufficiently independent to permit of such variation of route for each track as the meeting of obstructions in the construction should require; or briefly, I would have four independent tunnels, all four meeting at a common station once every mile and a half, and the way tunnels meeting at common stations every third of a mile.

What are the advantages of such a method?

1. A much stronger construction is possible with the same weight of materials, because a tunnel of twelve or thirteen feet in diameter can be built with strength to support a given outside pressure with much less than one-quarter of the weight of material required to build a tunnel of four times the area, and a tunnel to accommodate four tracks would have more than four times the area of a tunnel to accommodate one.

2. At any given depth there will be far less interference with, and danger to, the foundations of a building with a small tunnel than with a large one; in fact, a tunnel of the smaller size could be run with perfect safety almost through and certainly under or alongside the very foundations of the heaviest buildings.

3. The nearer the surface a system is run, the greater the variety of obstructions which will be met; which with a large tunnel would require a very costly change of gas, sewer and other pipes. A thirteen-foot tunnel, independently run, could easily deviate up or down, to the right or left, in fact, weave its way through and around obstructions, which it would be impossible to do with a larger tunnel. This is one of the very greatest advantages to be obtained with the independent tunnel construction.

Is any special plan necessary for the express route?

The express route, if a difference of level exists between express and way tracks, should be the lower one, and being lower it can run in more direct lines with less necessity of divergence on account of obstructions. While the express tracks should thus run in the most direct line possible between main stations, the way tracks could take a more or less divergent path as determined by the best positions for the way stations. On this account the express route would be somewhat shorter than the way, which would be an important help to a quick schedule time.

If, as should be the case, the tunnel is built of iron and of circular cross section, not only will the construction be the strongest which can be built for any given clearance, but with the minimum of excavations. It would present the maximum of resistance to vertical and side pressure. The thickness can be varied to suit the condition of strain to be met.

Do you think that such a method would materially lessen the difficulties of construction?

I do; but in considering the strength of construction and facility for finding a path, we must consider the time occupied also. By sinking shafts at sufficiently short intervals, and working in both directions on all headings, the construction of way and express tunnels can go ahead simultaneously and independently, each being completed at the earliest moment, and no tunnel being dependent upon any abnormal obstruction or difficulties which may be found in the way in the construction of another. A greater force of men can be used, the debris can be carried away more rapidly, and, in short, the whole work can be carried forward far more expeditiously and safely with the independent tunnel construction than with a larger tunnel, unless the latter were driven through solid rock at a very great depth. Of course, an accurate survey of the pipes and foundations of the city should be made and a great deal of other preliminary work would have to be done. I think, however, I am safe in saying that such a survey, the determination of route, sinking of shafts, condemnation of property, and provision of necessary machinery for work, could be made in six months after a determined body of capitalists, armed with the proper franchise, which could be granted by the city, should be ready for operation, and the entire New York city line could be ready for active operation within eighteen months thereafter. The cost of such a construction would be about $500,000 per mile of single tunnel.

How would you secure the effective ingress and egress of passengers to and from the stations?

Accessibility to all trains, no matter whether way or express, or for up or down or cross-town tracks, and for change from one train to another, is an important provision. This facility of access to trains can only be had where there is a common station, which station should be between the up and down tracks, and should be roomy, well lighted and easy to reach from the street. Sole dependence should not be placed on elevator service, although such should be provided whenever of advantage. At way stations a common platform between two tracks is easily provided, because the two tracks are on the same level, and there is nothing to provide for special changes. At the common way and express stations, however, a somewhat more elaborate station system should be adopted; the depth of the way tracks below the surface would be the same here as at regular way stations, but the express tracks would be about thirteen feet lower, and preferably directly under the way tracks; thus the four trains would there occupy the four corners of a parallelogram. Elevators, when used, should be in the centre of the station, open on both sides, and operated primarily by electricity. The entrance to stations should take no street room, and hence form no obstruction; the stations and offices should occupy the first floor and deep basement of a building especially constructed for the purpose, all the upper portion of which could be utilized for ordinary business purposes, and two or more elevators could run the full height of the building from the station platform.

Crossings on grade would be rather risky underground, I presume?

There should be no grade crossings. While the importance of this rule has met with little recognition in this country, and does not mark any widespread practice here, yet it is the standard practice of the main trunk lines in London. Its merits need little comment, because whatever other conditions may exist, high speed, safety and regularity of service can only be had in a fully satisfactory manner where there is a clear right of way.

A four-track system, such as I have outlined, running up the east side, thence by loops through the annexed district and at the Harlem river, thence down the west side, completing its circuit by way of the Battery, would necessarily have cross-town connections. These should be two tracks only, and should pass beneath the main system, with access from the common station, whether express or way, and as two-track systems they could be continued under the East and North rivers. One of the most useful of such cross-town connections would be the loop already described making connection between the New York city system and the various street railway and trunk line systems of Long Island City, Brooklyn, Hoboken and Jersey City, and whatever underground railway systems might afterward be developed there. A two-track system for this loop would practically provide express service, because on a larger portion of it, that under the rivers, there would be no necessity for stoppages, and the stated intervals would be sufficiently long to allow of high speed.

From what you have already said, I presume you would virtually ignore the necessity of providing for direct connections with other lines?

I certainly would. The depth of the New York system of tunnels should be no more dependent upon that of the cross-town loop than upon the height of the elevated railroad or the Pennsylvania terminal tracks, the level of the horse car tracks, the platform of the ferry boats or the arch of the Brooklyn bridge. It is impossible to accommodate all.

There should indeed be no connection between an express and a way track, except at the despatching and siding stations, where everything could be under the most rigid personal supervision, and where the necessary complication of tracks can be properly supervised. Switches even between the way tracks and between the express tracks should be only used in a case of emergency, and the main line of rails should be absolutely unbroken. The roadbed would be of the most rigid and even character, and the weight of rail commensurate with the duty.

Could you rely on such a system for improved train service?

Train intervals and passenger requirements should determine the length of trains, instead of length of trains determining train intervals. It is not express service to have to wait ten or fifteen minutes for an express train after leaving a way one. The most frequent interval that can be safely run is that which should be adopted, of course with reasonable regard to the amount of passenger traffic, which, however, will be better accommodated at certain portions of the days by smaller units and more frequent trains. The number of cars in a unit determines the number of passengers that can be carried with a given safe interval between trains, because the time of discharging and taking on passengers will be almost constant with a given traffic per car whether the trains be long or short. So long as there is only a safe interval between a train standing at the station and one approaching it, the train unit is not too small for passenger requirements, providing the following train is not delayed. When, however, the following train has to wait on approaching a station for another train to clear the way, the train unit is too small. The use of way and express tracks would relieve that congestion of traffic which characterizes the two-track system of the elevated railroads, and which on any two-track road cannot be avoided in New York.

What shall be the motive power of such a system as you have outlined?

Electricity will unquestionably be the motive power. The hum of an electric motor is a song of emancipation. As in independent way and express system of tracks should be an essential of a rapid transit system, so also should the use of electricity as a motive power be *sine qua non*, and accepting the statement that this agent is capable of satisfying in the highest degree the most exacting demands of service, the system should be planned with special reference to its use. One great trouble with most of the rapid transit plans which have been proposed is that they have been designed from a steam engineer's point of view. Steam practice has determined not only the form of roadbed or tunnel, but also the laying of the tracks, the construction of the cars, the ventilation and lighting of the trains and the roadway, the length of trains, the system of switching and despatching; in short, there has been scant recognition of the fact that electricity has, within the past three years, jumped to the front with tremendous strides, and given practical and most conclusive proof of its pre-eminent fitness for at least all transit of this character. Many of these systems were planned before the science of electricity was in its swaddling clothes, and even recently, when electricity has been spoken of by the steam engineer, it has been with a somewhat definite idea that electrical engineers would fit their conceptions to steam demands, but this will not be done. The best informed of them know that the time has come when it will accept no secondary place; that there is nothing which steam can do in the matter of handling trains, certainly within the limits here considered, which electricity cannot, in a more satisfactory and a more perfect manner, perform.

How far does the history of the development of electric traction corroborate this view?

The development of electric traction is unequaled in the industrial history of the world. In 1886, a list of twelve or thirteen comprised all the electrical roads in operation, and this included every electrical road in the world, whether operated by the split tube, the side rail, the traveling trolley carriage on an overhead wire, the centre rail, or by a conduit or storage battery. There was little similarity in these different plans, but they all served to show that electricity, in a more or less effective way, could propel a car. But street railway men were disbelievers, capitalists skeptical, car-builders cynical, and most electricians only hopeful. Almost three years ago to-day, the 2nd of February, 1888, there was opened for traffic, a road at Richmond, Va., which presented conditions of length, grade, curves, roadbed and number of cars to be operated, which, if successfully overcome, would mark a new era in the development of electric railway traction. The conditions, while not perhaps now seeming remarkable, were then considered insurmountable, not only because of difficulties relating to street car service itself, but also because of electrical and mechanical ones. The length was from eleven to twelve miles. There was a straight grade of ten per cent.; there were grades in curves of seven and eight per cent. There were twenty-nine curves, and some were as low as twenty-seven and thirty foot radius. The road-bed was of an execrable character. Thirty cars had to be operated at one time from a common station, and some of them four miles away. That road had its vicissitudes, but its victories as well. Forty cars were operated, and no less than twenty-two simultaneously at one end of the line. The electrical and mechanical features, hastily designed and crudely constructed, were a radical departure from previous work. They constituted what is known as the Sprague system, and in the words of Franklin Leonard Pope, "Many of the characteristic features at that time designed and introduced have practically become standards in the modern system, and are found in nearly every one of the thousands of cars now in service."

The question of electrical propulsion was there settled, and that road stands as the pioneer of the marvelous development of the past three years, until there are now in operation in the United States alone, no less than 310 electric railways, operating over 2,400 miles of track, with 4,000 cars, equipped with about 7,000 motors, representing no less than 175,000 h. p. in dynamos and motors. Not less than 400,000 miles are made a day, and three-quarters of a billion passengers carried annually. Although only three years have passed, one-third of the entire mileage of street railways is electrical, and there is scarcely a road in the United States that is not considering the application of electricity.

How does electric traction compare as an investment?

Horse railroads which have been in use for over fifty years represent an investment of about $58,000,000; electric railways, over $50,000,000, while the cable roads, which have had a commercial existence four times that of the electric system, have less investment than electrical railways, or about $49,000,000. So you see there is reason for my statement that there has been no equally remarkable growth in the industrial history of the world.

The equipments of roads by this system, or detail modifications of it, now constitute a large proportion of the business of the largest four electric companies in the United States, and the system has not only gained such hold in this country, but is being introduced in Germany and Australia, is ascending the ancient hills of Fiesole, at Florence, and has invaded the dominions of the Mikado.

What is your opinion as to the City and South London electric road running underground?

That road was first designed as a cable road, but the remarkable success of electric traction in the United States had much to do with the change to an electric system, which has been carried out with remarkable success under the supervision of Drs. John and Edward Hopkinson, and by the Messrs. Mather and Platt, of Manchester. New Yorkers are indebted to the energy and skill which has made the London road a success, because it stands in the same relation to city rapid transit as Richmond stands to the street railway development in the United States. It is the pioneer on a large and costly scale of an electric railway under new conditions, which, with modifications, can be best applied to our own needs. It will do that for capitalists who wish to embark in a rapid transit project what Richmond did for those interested in street railway service. It is, of course, a far more perfect equipment than was that of Richmond, for it had the advantage of two years' experience. That it can be improved upon is no criticism of it, but simply a statement that the ultimate, so far as the public is concerned, has not been reached in methods of motor construction and government.

What would be the general features of the electrical methods you would adopt?

Well, first, with reference to the method of supplying the current. This would undoubtedly be by the overhead single conductor underneath contact system, with rail and tunnel return, despite the criticisms of what is popularly known as the overhead wire system, which is the necessary street development, with many limitations, of the underneath plan. When such a system is used in the street, it must necessarily be of light weight, have few supports at long intervals, and meet with sharp curves, heavy grades and sudden changes of grade. There must be a variation in height of wire from 21 to 12 feet from the ground, or 1 to 10 feet above the car, to accommodate railway crossings and bridge roofs, and there must be a deviation of as much as four feet either side of a centre line. The conditions of construction cause more or less flexibility of the wire and of its supports, hence the trolley pole of the, as Dr. Holmes has so happily dubbed it, "broom stick train," must have a remarkable freedom of movement, and the contact wheel must be grooved in order that the wire may govern the movements of the arm. Despite these great disadvantages of condition and service, when the line is properly erected, the operation of the system is remarkably perfect under normal conditions, even up to a speed of thirty miles per hour with an ordinary street car.

With a tunnel road, however, the conditions are entirely changed, save only that we still wish to move a train guided only by its tracks, as nearly as may be with perfect freedom between two planes. Here the overhead wire would be replaced by a rigid rail, supported at short intervals at a fixed distance from the roadbed, and following accurately the centre line of all track and switch paths. The variation of distance from the motor car top will be practically nothing if a separate motor car be employed, and the settling of the car springs under a load, if the motor car carries passengers, would be the extreme limit of vertical movement. Grooved wheels and long poles would be discarded, and replaced by an upward pressing contact having a limited universal flexibility corresponding to the movements of the car upon its springs and any little irregularity of the tracks and the overhead conductor.

We would then have a system in which the electrical part, or rather the overhead conductor, because all parts would be electrical, would be just as rigid and permanent as the roadbed, and we should have perfection of insulation, freedom from personal liability, continuous contact with a single device, and speed limited only by the capacity of the motors. With such an overhead conductor, a speed of 120 miles per hour has already been successfully obtained on experimental work.

The so-called difficulties of the overhead system would then absolutely dissappear. A centre rail system, with the conductor near the level of the tracks, must necessarily be broken at all switches, thus requiring double contacts on motor car, and cannot offer the same advantages of insulation and freedom from personal contact. The overhead system would have been used upon the London road if there had been room enough. Of this I was assured by the consulting engineer of the road.

Then comes the consideration of the dynamos and motors.

The current could be supplied to this entire system for not only the motive power, but for lighting, and, if necessary, for ventilation, by seven central stations situated on the water front at Kingsbridge, the Harlem river near 129th and 160th streets, West Twenty-third street, Jersey City, Atlantic Ferry and Greenpoint. With these stations the electrical potential would be comparatively low. The station would be operated by triple expansion condensing engines in three units, each driving a pair of multipolar slow speed dynamos directly coupled, the units being large enough so that two engines could handle the normal maximum demand upon the station. The economy of coal consumption under these conditions is too well-known to need comment.

While for purposes of traction, quick getting under way, and for marvelous braking power in case of emergency, a motor on every truck with control from a pilot car is possible and would be a great service. I think it likely that an independent motor car will be found to be more advantageous, because of the care which the machines can have, the lack of necessity to subordinate the motor to abnormal conditions, and because, with the grades which an underground system will present, and with the constant coefficient of traction which the rails would have, a motor car could be relied upon to efficiently handle six times its own weight of passenger cars behind it. Multiplicity of parts should ordinarily be avoided, and the construction of the cars which the tunnel can best have, might make the use of a motor under each car inconvenient.

It is unnecessary to go into the question of motor construction. Gearing will be done away with, slow speed motors used, directly coupled, and it is safe to say that they will be quite as reliable as the best steam locomotive.

What system of braking would you advocate?

For use on an electric train, not only is every system of braking in common use, the vacuum, the air, whether the continuous pressure or the stored reservoir system, available, but more than this, and acting with a certainty, rapidity, and delicacy almost inconceivable, is the dynamo power of the motor system.

In a perfect system of transmission, every car running on a down grade, while not accelerating its speed, and every car coming to a stop, ought to be of service in helping to propel other cars. As already pointed out, the work done on a train may be divided into three classes: First, the work of accelerating the speed, that is, from getting from zero up to its maximum speed, the process of imparting to the train a certain amount of stored-up energy, which, when trains are stopped by the use of the brake in the ordinary manner, is nearly all wasted. Second, in lifting the train from one level to another, that is, grade work; this is partially recovered on down grades, more so on express service than it can be on way service, on account of the less frequent stops. Third, traction, the work expended in hauling a train on a level.

This would be true of the cable system also, would it not?

In a cable system running on a straight line, cars which are running on down grades do help to pull others on level or up grades, but the amount of power used to propel the cable itself is so largely in excess of that used for propelling the cars that this is not of much importance, and on roads with curves it becomes even less so. Slowing down cars on cable roads is of no service in restoring energy to the system. In an electric road, however, when operated under proper conditions, all this is changed. There is intimate and instant relationship between every foot of the system, and a train slowing down, or a train running on a down grade, can give back a large proportion of the energy to the system for use on other trains. The transmission of the energy by the current proceeds with calm indifference to grades and curves, or the condition of the thermometer or the barometer, and serenely annihilates time and space. Be it hot or cold, wet or dry, the interchange of energy is perfect.

This method of braking is of great commercial importance, since by it there is a saving of about 40 per cent. in the amount of power at the central stations, and it effects a similar saving in the size and cost of stations and conductors. Instead of the current being all supplied by the main generating stations, it would be also supplied by nearly as many moving stations along the line as there would be trains slowing down or running on a down grade. In fact, the loss of the two conversions and one transmission would be fully conterbalanced, and the original horse-power at the central station would be no more than the aggregate net horse-power developed on the entire line.

Another method of using the motors for braking purposes is to brake the connection from the line and reverse the machine through a local circuit on the train, varying either the local circuit or the circuits of the machine. While in this position of braking, if the local circuit is opened and the line connection made, the machine would be instantly reversed.

How do these ideas stand the test of actual work?

Elaborate experiments have been made in handling a car without shoe-brakes by these methods of braking. When desired, the braking could be made so sudden as to cause the wheels to have a continuous skidding rotation, not such a skidding as is caused when an air brake is put on too sharply, but a rotating slip which is just enough to relieve the motor when the strain on it reaches the point determined by the coefficient of adhesion on the rails. This is the ideal method of braking, because fixed skidding and flat wheels are an impossibility and the wheels will turn until the train comes to a dead stop, although, where the braking power is put on too suddenly and exceeds the grip of the wheels, they will relieve themselves by slipping just enough to keep the braking at the maximum limit. A train so governed can be made to creep down the maximum grade of a road at a snail's pace, and in an emergency, such a car, running twenty-one miles an hour on a down grade, has been stopped and reversed within ninety feet.

When an electric motor is reversed, its action is cumulative, and thus much increases the effort to stop itself; and the higher the velocity at which it is traveling, the greater this effort. In fact it would be practically impossible, with a properly constructed railroad motor, to prevent its reversing when the switch is thrown over far enough.

Do any other points of discussion occur to you?

I do not think further argument is necessary to demonstrate the advantages of the electrical method of propulsion. This being granted, we have at hand the means for the construction of a rapid transit road far in advance of any system at present operated, and answering the peculiar demands of New York in the highest degree; a comprehensive system with way and express trains, starting and stopping promptly and smoothly, moving at a high rate of speed and running at short intervals, with none of the objectionable features of the present steam systems, and an enterprise having an incalculable influence on the future of this city, and on the health and happiness of our people.

A "RAPID TRANSIT" DINNER AT THE NEW YORK ELECTRIC CLUB.

The monthly dinner of the Club at its Club House, on February 27, was followed by a discussion of the topic "Rapid Transit for Cities." Although the night was extremely stormy, the attendance was large. President O. E. Madden called to order about 8:30, and after a "rapid transit" disposal of some routine business, letters of regret were read from the Mayor, Hon. Hugh J. Grant, and from President H. M. Watson, of the American Street Railway Association. Telegrams of regret were also received from Capt. Eugene Griffin, of Boston, and President T. C. Barr, of the Newark Street Railroad. President J. W. McNamara, of the Albany City Railway, operated by the overhead trolley system, wrote, expressing his opinion that rapid transit for all large cities would be found in underground railways, but that cities of less than 500,000 inhabitants must be content to have such rapid transit as may be afforded them by means of surface roads. "In my opinion," he said, "all roads in the near future will be operated by means of power transmitted by electricity in some form." Mr. F. H. Monks, general manager of the West End Street Railway Co., of Boston, wrote as follows: "Having given this subject most careful consideration, I am constrained to believe that a four track elevated road allowing two tracks for express trains and two tracks for way service built through the congested part of a city to the suburbs and connecting there with surface lines," with one fare all through, would meet the needs of the city for many years. Mr. F. S. Pearson. the engineer of the West End Railway, expressed the belief that in New York a tunnel system and four tracks would meet the exigencies of the case, with electricity as a motive power. He ridiculed the statements made in some of the New York daily papers as to the overhead trolley wires in Boston, and said: "In all the experience of the West End road since the adoption of electricity, there has not been a single instance of failure in the overhead lines during the storms which have played havoc with other wires. My objection to the appearance of the overhead work would seem rather absurd, inasmuch as the elevated railroad structures are tolerated." Col. F. K. Hain, general manager of the Manhattan Railway, regretted his inability to be present, and "would prefer not to give his views as to the manner in which he would grapple with the difficulties of the rapidly growing passenger traffic in New York."

Commissioner Heintz, of the Annexed District of New York, said: "We have always felt slighted, in the 23rd and 24th wards, by the fact that people do not seem to look upon us as part and parcel of the city of New York. The reason why we have been ignored is the absence of the very thing under discussion tonight—Rapid Transit. People have not had a chance to discover the whole of New York city. We owe it to ourselves to make officials understand that we must have rapid transit at all hazards, and if we do that we are bound to get it in the near future."

Mr. Frank J. Sprague began a very able address on "The Rapid Transit Situation in New York," by a summary of his views on the New York situation as given in an interview in the *Commercial Advertiser*,[1] and by saying: "There is no Rapid Transit; it is all situation." He described graphically the trials, tribulations and triumphs of electrical engineers in street railway work during the last five years, and said:—

Boston, Cleveland, Milwaukee, Minneapolis, St. Paul, and St. Louis, with all their adverse conditions of ice and snow, support the largest electric railway systems. Of all the thousands of people employed in the various duties of electric railway work, not one has ever been sacrificed by contact with the standard pressure which has been adopted for street work. Over fifty million dollars represents the investment of one class of electric motor work alone in this country.

Such has been the change wrought within the past three years. Can any observing man avoid the conclusion outlined by these facts; that the electric motor must not only be the propelling power of any rapid transit system in this city, but that system in its entirety must be designed with special reference to its use.

Not alone in street car work, where the electric motor now holds undeniable sway, but already in inter-city communication is it outstripping the steam locomotive. Between Minneapolis and St. Paul, a distance of ten miles, 13 cars are performing an eight minute service at good speeds in competition with the old established steam railway half hour service; and, although the fare including transfer to the city, systems is less than one-half that charged on the steam service, the operation of the cars is a most remunerative business. An electric railway line over 100 miles in length is now seriously projected in Austria. My own investigations have convinced me that at a frequent interval rapid service is perfectly feasible between here and Philadelphia.

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[1] See page 278.

A most instructive table has recently been made showing a comparative statement of earnings of horse, electric and steam railways for city communication. This table comprises returns for all the street railways of Massachusetts, the entire West End Railway system of Boston, the Manhattan Elevated Railroad, and three specimen divisions of horse and electric railway service in Boston, and shows the car mileage and passengers carried, the receipts, operating expenses and net earnings per car mile and per passenger carried. The figures are most suggestive and they bear out in a remarkable way my own claims and prophesies of electric railway possibilities some years ago. To quote a few of the results, I find that on the Massachusetts railways with about 24,000,000 miles car mileage and nearly 150,000,000 passengers carried, the operating expenses per car mile are 25½ cents, of which about 10½ cents is for motive power, while the percentage of operating expenses to passenger receipts is 82 per cent. This almost exactly represents the facts on the entire West End Railway system when operated by horses. Coming to a more recent period I find that with three horse divisions making something over 3,000,000 miles, and carrying nearly 20,000,000 passengers, the operating expenses per car mile are a shade under 25 cents with the percentage of expenses to receipts about the same as before, 81.7. Three electric divisions, making nearly 2,500,000 miles and carrying nearly 16,000,000 passengers, give operating expenses of 20¼ cents and the percentage of operating expenses to receipts 64 per cent.—a most remarkable showing. Compare these figures with those of the operation of the Manhattan Elevated Railroad, which, for the year ending September 30th, '89, made nearly 31,000,000 miles and carried nearly 180,000,000 passengers. Its operating expenses per car mile was 17⅔ cents—a little over 2½ cents below that of the electric system, and the percentage of expenses to receipts 60.4 as against 64 per cent. for the electric system.

It has been generally supposed that this steam system was much more economical, but when we consider the tremendous traffic on the elevated railroads, and the fact that while they only have one engine to every four large cars, under exceptionable care, and they are the product of years of best development and experience, while the electric cars have had one and two motors for each car, exposed to the worst possible conditions, and with only practically three years' development, the difference of operating expenses is more than made up by repairs, and, I think, we can safely say that the electric motor has already impressed its stamp of commercial supremacy in the unerring imprint of dollars and cents, and with the future electric motor designed to meet the conditions of train service, subject to the same care that the steam locomotive is, there is no question that it will undeniably be far in advance.

So much for electricity. How should it be used? What shall be the routes over which to operate? What shall be the form of road? Shall it be elevated, surface or underground? How many tracks shall it have and what shall be the system of train service? Thanks to the electrical development, and thanks also to other modern engineering advances, and especially as they have been so cleverly and intelligently put into practical operation by Mr. James Greathead, whose representative I see here and who is better able than I to describe his methods as applied to the City and South London electric railway and well as other work, the answer to these questions seems to be an easy one, and it is an answer which a very few years ago could not have been given.

Mr. Sprague then reviewed the various schemes and asked: Where then shall be put a road? Underground. While I have been an advocate, and still am, to erect one solitary wire for an electric railway system to replace horse car service, I have thought perhaps that the Biblical admonition, "Dust thou art, and into dust thou shalt return," might just as well be applied when necessary to all electricity as to poor humanity. Despite the somewhat exaggerated claims of my telephone friends, I am no believer in the so called "God's free air," as applied to rapid transit systems in New York, because, what, with our lofty buildings, and the occupancy of our streets with the elevated structure and poles of various kinds, we have no free air; but, provided we go deep enough, I am a strong believer in God's freer earth, which is our common heritage; so I say again, let us go underground, but this is not all. What shall be the form of the underground construction?

Bearing in mind the character of our soil, the accessibility of the system, the necessity of running through and along side foundations of structures without weakening them, there seems to me but one really available system for New York. I favor, in brief, four independent iron tunnels, all meeting at a common station, once every mile and a half or so, the way tunnels meeting at common stations every third of a mile, every tunnel being absolutely independent in its route except at the stations, the way routes being run to accommodate the best surface intersections for existing lines of travel; and the express route, while passing beneath the way tracks at the common stations, elsewhere running in the most direct possible paths. Such a four-track system should run up the east side, thence by loops through the annexed district and at Harlem river, thence down the west side, completing a circuit by way of the Battery. This should intersect with a two-track system passing beneath the main system with access from common stations crossing New York on the 42nd street line and at the Battery, and making connections with the Long Island, Broadway and Atlantic avenue stations on the Brooklyn side, and the Trunk Line Depots on the Jersey Shore. This system comprises about 125 miles of single tunnel for New York and 30 miles of tunnel in the loop, and would provide a most comprehensive system of intercommunication. The schedule running on way service to be 15 miles an hour, and on express service 30 miles; and how different such a tunnel would be from that which we have known? A rigid iron structure with all vibration deadened by the surrounding soil, an almost perfectly equable temperature, a magnificent roadbed, perfectly jointed and free from expansion and contraction, absence from dust, smoke and cinders, perfect ventilation, a structure unobtrusive in character and absolutely safe, derailment almost an impossibility, a system of braking and signaling unequaled, and a prompt and reliable high speed service. Let us hope that we all may be prominent in accomplishing this result.

Mr. C. O. Mailloux, speaking of rapid transit in Washington, where he is putting in a plant for 40 storage battery cars for the Metropolitan Co., said: "The bill passed by Congress forbids the use of any overhead appliances. That restricts the systems to the underground electrical, the cable and the storage battery. All things being considered, there was only one thing left to do, and that was to use the storage battery system, which I hope can be developed to a sufficiently practical state to solve just exactly the problem now before us in Washington."

Mr. G. M. Phelps, by invitation of the President, here set in motion the Davenport model electric railway some fifty-five years old, and he stated the circumstances under which it was recently discovered by Mr. F. L. Pope and rescued from oblivion and the dust heap. Both Mr. Phelps and President Madden drew attention to the dramatic contrast presented between this old model of a brave and struggling inventor, who was far ahead of his age, and the latest development of electric traction, exemplified in the model of the underground electric road in London, standing on an adjoining table. President Madden then introduced Mr. Louis Sterne, C. E., to speak for this latest development.

Mr. Louis Sterne, C. E., said: The common desire in all cities is the rapid communication from residential to business centres, and thus to relieve the already overcrowded thoroughfares and existing means of transit, as population grows in any great metropolis with commercial and industrial prosperity, such as London and New York.

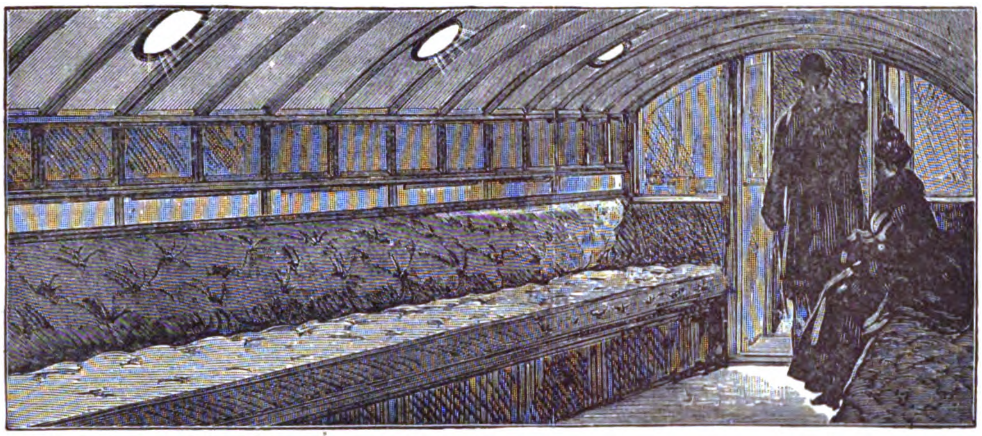
New York differs essentially in many particulars from other great centres of population, although the common desire to be quickly transported from place to place is univesal in every city; but the configuration of New York city concentrates the pressure of the greater portion of the population, especially as the business portion is at the lower end of the city, and thus compels the movement of the larger part of its male population in opposite directions once in each day. London has always been more favored in this respect as it has had an excellent omnibus service which has trebled in point of numbers, and has numerically increased in its transport of passengers in exact or even greater proportion. The cabs in London, with the strict enforcement of legal regulations and the low rate of fare, have also contributed largely towards the conveyance of persons from place to place. The pressure in London, therefore, is not so great, although they have made the advance over New York in seeking to solve the problem of rapid transit.

Two tunnels were built in London, one by Mr. Brunel in 1860, and one by Mr. Greathead in 1868-9; the former fell into disuse until the Metropolitan Railway used it as the means of reaching the Surrey side of the river, and made their terminal at New Cross, some four miles from the mouth of the Brunel tunnel. The Tower subway, designed and built by Mr. Greathead and Mr. Barlow for omnibus traffic by gravitation, is used only for foot-passengers to the extent of about 100,000 a month. The original plans were never carried out for want of funds.

The next approach to a tunnel was the well-known Metropolitan Underground, and since then the District Metropolitan, now known as the Inner and Outer Circle, a small portion of which has cost as much as at the rate of $30,000,000 per mile. These have been supplemented to a very considerable extent by the main lines of railway, both north, south, east and west of London, having their terminals as near the business centres as possible, and with the running powers over the Metropolitan Railway, carrying an immense number of passengers from the suburban districts of London. In addition to this, we have in the city of London between 15,000 and 16,000 cabs, carrying passengers at 12 cents per mile.

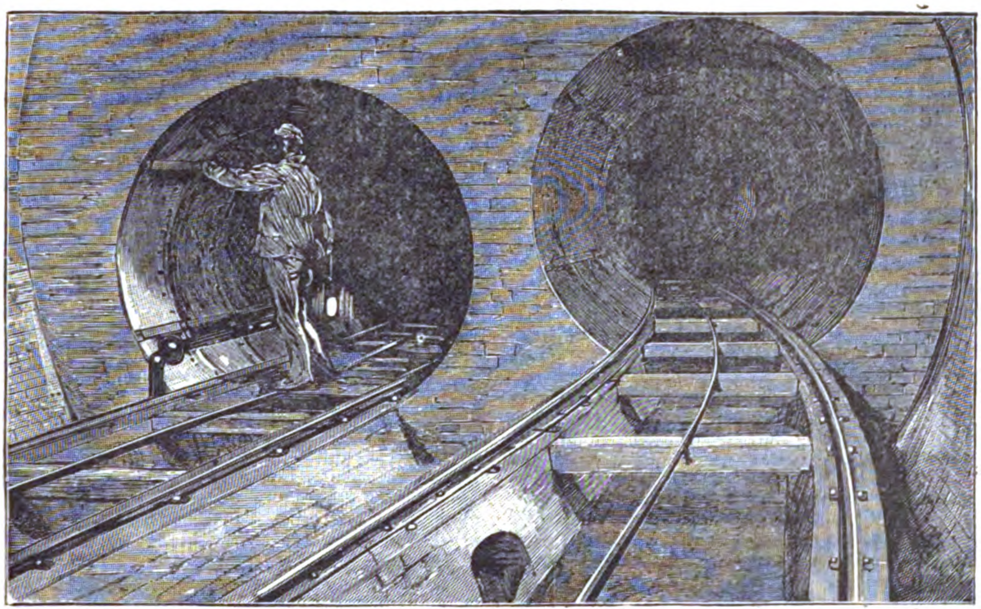
Street cars have also been laid down in the streets of London in the last 20 years, but these are not permitted to enter beyond what is technically known as the City limits. Thus their usefulness for a continuous journey across or through the metropolis has been minimized.

Underground Railways.—Many attempts have been made by the Metropolitan and District Railways, and also by private corporations, as promoters, for increased facilities in London, but the moment they showed on the walls of the committee rooms, either in the House of Commons or in the House of Lords, the old system of disturbing streets and vested rights and properties, with the old method of traction involving asphyxiating air, brick porous lining, and the smoke and gases of the engine, the bills were thrown out and never came beyond the first committee.



Passenger Car, City and South London Railway.

Subway work ceased, until cable traction suggested to Mr. Greathead the possibility of making his system of deep tunneling successful for rapid transit. Mr. Greathead's name is now as well known in Great Britain and is as closely associated with deep tunneling as the name of Mr. Edison is associated with electricity. Although the cable suggested the possible traction in deep tunnels, electricity solved this problem for Mr. Greathead, as neither safety nor speed in cable traction can compare with that of electricity, and the iron lined and cemented tunnel lends itself perfectly to electric traction. (The tunnels of the City and South London road are shown in the accompanying illustration.)



Tunnels of City and South London Railway.

The American people will not be slow in adopting the improvement thus developed in Great Britain, and which will make underground means of transit as safe and as healthful as the surface roads have been until now; and will also make these substructures in all cities in the United States as important an element as the elevators have proved in utilizing the upper streets, and practically doubling the area of the densely populated districts of every great city in the United States. You have not lost much time in adopting these improvements in the mode of rapid transit underground, and you probably have profited by waiting until the advance came to you from Great Britain. Just as you have benefited by postponing the building of a United States Navy and naval armaments, you have been enabled to take advantage of all that has been done, and adopted the best design of the many cruisers which formed the experimental period preceding the building of your navy, and thus saved many millions of dollars and much vexation; and it may not be long before Great Britain will have to look to the United States for the adoption of many improvements made here.

You are fortunate in having such an earnest and able commission appointed by your chief magistrate—an appointment confirmed by the State, and with full powers to give the necessary facilities for rapid transit in New York, and for New Yorkers especially.

Mr. Sterne added that the City and South London road in its first six weeks had carried 1,100,000 passengers, and had run about 11,000 trains with only 18 failures to make schedule time. The road is now to be extended northward, from the city to the Angel at Islington, and would be crossed at right angles by a 12 mile tunnel electric road running along Oxford street, Holborn, Newgate street, Cheapside and Cornhill.

Mr. Sterne illustrated his remarks by frequent references to a large map of London and a large model of a section of the Greathead tunnel as used in the City and South London electric railway.[1]

Mr. H. H. Neill, of the *Commercial Advertiser*, spoke of the relation of the New York press to the city's rapid transit problem, presenting in a most entertaining manner the "momentarily popular," the "probably successful," and the "everlastingly right" aspects of the question. He argued, with much force, against any attempt to deal with the question other than by a solution that would be permanently effective and adequate.

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[1] See for full description of the electrical plant, The Electrical Engineer of Nov. 26, 1890.

Mr. Sterne: I would like to say that I forgot, during my remarks, to state that the Hudson River tunnel is now being built on the Greathead system, and we are advancing there at the rate of ten feet a day. The last two or three days we have really made 15 feet a day.

Mr. T. Graham Gribble spoke on Rapid Transit in London and New York, with special reference to the topographical characteristics of the latter city. He described briefly the duplex railway system, the adoption of which, as a means of solving the rapid transit problem, he recently advocated before the commissioners.

Mr. W. J. Richardson, secretary of the American Street Railway Association, said: I received this morning a letter in which occurs this sentence: "Boston, Albany, Washington, Brooklyn, New York and London will be spoken for, and what I want is to leave the rest of the country to you." There is nothing small about the man who includes within the confines of the United States the City of London. (Laughter.) There is nothing insular about Mr. T. C. Martin. Indeed he can only be adequately compared to the telephone people who want the earth, or rather, let me say, he is like the generous electrical street railway man who is willing to divide the earth with everybody. (Laughter.) Mr. Richardson then spoke eloquently of the good work that street railway men were doing in their respective communities.

Mr. Charles E. Emery, the distinguished steam engineer, said: The relations of the electrical systems to steam settle themselves by the facts. We may put down a cable running through a groove, but at the end of it we have a steam engine, a boiler, and a place to burn the coal. We have overhead a wire which the trolley presses; but at the end of that is a dynamo, the engine, and the place to burn the coal. As yet we have no good pyromagnetic machine, and so long as you must burn the coal and make the steam, the steam engine directly applied will, for very long routes, take the lead. The locomotive is not as economical as the triple expansion engine, to be sure, and you can run the dynamos with triple compound engines and get down to 15 pounds of water per horse-power per hour, and coal proportionately; while the locomotive will take 24 to 26. But you have first this conversion into electricity in the dynamo, and the conversion of the electricity into power in the motor, you have a double loss, and if you get 75 per cent. when you get through, you have done well. It will run down, undoubtedly, in the neighborhood of 50 or 60 per cent. when you average up. So that the gain you get by the triple compound engine is lost by the necessity of going through so many operations before you get the power. Now, you are only even. Therefore it seems there is a chance for electric motors even on railroads of considerable length. No. You are handicapped again by the necessity of having these electrical conductors, and the farther apart the stations the larger the conducting wires must be, and therefore it does not seem feasible. But it does seem that the steam engine directly applied, for roads of considerable length, will hold the lead for a considerable number of years.

Speaking of the plan which seemed to be the best adapted for rapid transit in New York, we come back to the necessity of having four tracks on each main line, one on each side of the city. We need the double line for four tracks, and where shall that be put? New York needs more through streets from the lower to the upper part of the city. A plan was thought of to run through Elm street. No matter where it is put, that street should be run through. Then, when the new street is opened, the excavation could be carried down to the depth required to put in four tracks. In connection with that there should be a surface railway above. That street should be wide enough, if practicable, to put a wall at each side of two central surface tracks and let the electric cars—for they would be electric cars—run there. You could run the local stations to a greater distance, perhaps a mile, or even three-quarters of a mile might be a better compromise, and then the express stations two to three miles. Then you would have rapid transit.

Unfortunately, gentlemen, you have all to use steam engines as yet. We therefore consider that steam is a necessity of the case, but that on account of the losses in small motors, on account of the gases which accumulate in the tunnels, the electric motor has solved the difficulty of running through places where steam cannot go. Therefore, while I quite agree with all here present as to the value of this system, it takes its place only as one of the many means which we have at our command to solve the greater and broader problem. (Applause,)

Mr. Edward Weston said:—I shall not attack the problem of rapid transit from what I should strictly call the point of view of engineering difficulties as separated from the electrical difficulties connected with it. I take it for granted that the engineering difficulties can readily be surmounted; that they are not very serious in character outside of the question of cost. Many years ago Brunel designed and constructed the "Great Eastern." You know how much trouble that steamship gave the company which was organized for building it. Considerable litigation sprang up in consequence of those difficulties, and during some of the litigation Brunel was put upon the witness stand and was considerably annoyed by the questioning of the counsel on the opposite side who twitted him upon his failure to successfully launch the ship without wrecking the company. One of the lawyers who was somewhat brighter, apparently, than the rest, asked Mr. Brunel some very sharp questions in regard to the "Great Eastern," and not getting very satisfactory replies, he suggested to Mr. Brunel, "I suppose you would not have any hesitation about building a tunnel from here to China." Brunel instantly replied, "No, sir; I would not hesitate about it one moment if you would not hesitate about raising the money to carry it through." In reality that was the much more difficult problem. That is largely the question in respect to rapid transit. We are located in a city where property values are very high. We must acquire the right of way for the passage of our trains for the accommodation of the public at large. Having acquired the right of way, the problem falls either upon the mechanical engineer who would take up entirely the old mechanical means of transmission, or upon him and upon the electrical engineer. In the latter case the responsibilities would be divided, the mechanical engineer taking care of what may be said to be the mechanical part of the business and the electrical engineer the electrical part. I shall dismiss the mechanical engineering branch, conceding that that can readily be overcome, and consider only the electrical engineering difficulties in the way. Mr. Emery has said that for the general purposes of carrying of passengers long distances steam takes the lead. It does to-day unquestionably. Does it necessarily follow that it should take the lead, because at the present moment we have to depend upon steam for the generation of the energy that we require to propel our electric vehicles? I do not think so. I think there lies a very grave mistake. The steam engine is an exceedingly inefficient means of transforming the energy derivable from the coal into available power or for doing useful work. Therein our hands are tied to a large extent and when it is considered that the best of our steam engines to-day do not yield us over about 10 per cent. of the actual energy of the coal, you can appreciate the unfortunate position of electrical engineers. Looking at the other side of the problem, how much that impresses itself upon us who have given steady attention to the thing, is very remarkable indeed. The dynamo can be made to-day to yield 98 or 99 per cent. of the energy expended upon driving it in actual electrical energy. Of that, 94 or 95 per cent. can, under proper design, be again utilized in the form of electrical energy. That is, it can be delivered out. Now, taking into consideration the extreme difference between the steam engine and the dynamo, and notwithstanding that the motor is not of the same efficiency as the dynamo, I venture to say that that is entirely a mistake. Whatever the generator will do in the shape of efficiency, that the motor will do. If we do not do it it is because we do not carefully study the problem or we are unwilling to spend more money to secure the results. But, the question as to the efficiency of these two systems, that is the efficiency of the motor and the efficiency of the generator as compared with the efficiency of the steam engine is not entirely one of the prime motor. It is another thing. In the locomotive we have to deal with a very different problem from what we have to deal with in the electric motor. In the electric motor the efficiency does not decrease very perceptibly with a reasonable decrease in size of the motor. In the steam engine, on the other hand, it does decrease with a reasonable decrease in size. Small electric motors can be made of nearly the same efficiency as larger ones. Now, such being the case, small motors applied to the axles or with their power diverted to the axles of the cars in such a manner as to eliminate all loss between the motor and the cars, will yield vastly greater results and better results than a single steam engine located at the head of the train. I think Mr. Sprague, some years ago, considered that question and pointed out the vast superiority of the electric system in efficiency as compared with the steam system when it was taken into consideration that each car had its unit motor and that the tractive force of the whole train was distributed, in about proportion to the actual load on the respective parts of the train. The tractive force in the case of a steam locomotive must all be put in the locomotive. We all know how many tons have to be put on a locomotive in order to get that tractive force, and how far that may be reduced, and how far the efficiency of the electric system may be made to exceed in general that of the steam system, will be better understood when that question is more thoroughly experimented on and studied than it has been so far. It does not follow by any means, that we must have a less efficiency by the intervention of an electric motor. On the contrary, it may be proved, and I think will be proved, that the electrical system will be more efficient than the steam system as generally employed.

In considering the question of what is the best means of rapid transit for a city like New York, we have a number of problems to deal with outside of the question of first efficiency or economy. There must be convenience, quickness of stopping and starting, and everyone will concede that the lighter the parts that are to be moved, the quicker we can stop and the quicker we can start, the less wear and tear, the less strain on our apparatus and generator. Consequently, the electrical system there should possess an enormous advantage over any steam system by reason of the very fact that from the lighter loads and the lighter weights you have to carry in proportion to the power developed, you could stop and start vastly quicker without injury to the machinery. Then, again, in the electric motor we have something entirely different from what we have in the steam engine. We have no reciprocating parts, but continuous rotary motion. The strains are all tangential, and that ought to aid greatly in running and maintenance. The electric motor of to-day is not what the electric motor of a few years hence will be. To-day we are struggling with difficulties connected with the commutator end of the line, which has been the great bugbear of all systems of electric railroads. Commutators and brushes require more care, outside of gearing connecting the cars, than anything else we have to deal with. They are the weakest spot in the motor and they are the weakest spot in the dynamo. The question arises, Can those difficulties be overcome? I think they can. But if they are not overcome, are they not already sufficiently overcome to warrant our placing our reliance upon such a system of transmission? Well, the railroads we have already built, I think, are a sufficient answer to that question. Much of the railroad work that has been done here has been experimental in character. It must continue to be experimental in character for some time to come.

In connection with the motor we are laboring under very serious difficulties in regard to regulation. In the electric motor we cannot do just exactly as we do in the steam—adjust our point of cut-off so as to secure the best results with a given load. With the steam engine you can do that to a certain extent with a given size of engine. With the electric motor, unfortunately, we cannot do that at present.

We have to govern our motors by varying the resistance in the circuit, which means loss, necessarily, because that resistance has to be overcome to some extent by the current passing through it or by reducing the intensity of the field magnetism, which also means loss. Now that is unfortunate; but is it necessary? I think not. The ideal electric motor for the transmission of power would be a motor running at a continuous and uniform speed and with a variable gearing, giving the motor the advantage of power when the car was first started. That we have not exactly reached. You all know that the man in front of the car stands with a regulating device in the cab. When he wants to change the speed of his motor he moves a switch or arm around which adjusts the current flowing through the motor. Now, as a matter of fact, the motor should adjust the current itself, and not the man, and the speed of the motor should remain absolutely constant, while for regulation between the motor and the gear on the driving wheels, you should depend on varying the mechanical advantage entirely.

The needs for such a system as we have to deal with here in the city of New York, where enormous amounts of power would be required, are not by any means easily solved. I do not think any direct current system would entirely answer the purpose without a large number of stations and comparatively small units of power. The difficulties in this respect, however, are not the same as we have to deal with in the transmission of currents of energy for electric lighting purposes. In such a system as is proposed here, the pressure can be largely increased without very great danger or without the limitation imposed by incandescent lamps or other things which we have to deal with, it being mainly a matter of insulation and proper construction of the apparatus. But even under those circumstances, considering that you may lay out a plan or system with great care for insulation, leaving a sufficient margin or factor of safety for all occasions, it does not seem to me very possible or probable that we could do that with a few central stations. We should have to have quite a number unless some system of conversion from high potential to low potential was adopted. During the last few years considerable development has taken place in the art of electric lighting in certain lines, which I may briefly refer to as the alternating current system. That system has extended over a very wide area and has come into quite extensive use and has grown very popular indeed. It is now well understood that that system does not bend itself very well to the transmission of power—that there are grave difficulties to be overcome, in connection with the motors. The coefficient of self induction, or the kick back, so to speak, of the motors themselves, alone interposes a great obstacle to the output per unit of weight. But there is no reason in the world why continuous current converters should not be made vastly to exceed in efficiency the alternating current under all conditions of load, which would enable us to distribute currents of enormously high potential over very long lines by means of comparatively small conductors. It seems to me that herein lies the future success of such a system as has been discussed here to-night; that if we expect to reach high speeds and get economical service we cannot hope for a distribution based upon the direct application of the current, but upon some modification of it through a secondary converter by direct current conversion.

As to what can be done here in regard to rapid transit, or anywhere else, under conditions most favorable to it, I take it for granted that none of us know. It can only be found out by actual test. There is no question about that. That the return will far exceed our most sanguine expectations in that direction I am sure. With skill, ingenuity and care, there is no question in my mind about the development of rapid transit in this city or any other by means of electricity.

Mr. Weston closed by an interesting reference to the near probability of obtaining effective pyromagnetic generators, and pointed out that current had already been successfully derived from the oxidation of carbon without the application of heat. He closed with the remark: "It does not seem to require very much to carry us further along to producing the thing itself. Whatever is done in that direction will come right into play in connection with the future rapid transit system of New York and the world outside."

The meeting then adjourned.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER 150 *Broadway, New York city.*

PLANT EFFICIENCY WITH HEDGEHOG TRANSFORMERS.

Mr. Stanley's paper in THE ELECTRICAL ENGINEER of December 10, calls for a reply from me. Mr. Stanley divides transformers into two classes, the closed circuit or "American" type, and the open or Gaulard and Gibbs type, the hedgehog being included in the Gaulard and Gibbs. I do not quite understand why the closed circuit transformer should be called American; it was not first invented by Mr. Stanley, nor was it first made in America, and it was already well known in 1885. This point has, however, nothing to do with the main subject of Mr. Stanley's paper, except in so far as it invokes national prejudice in favor of the closed circuit.

He says that in 1885, before adopting the closed circuit transformer, he considered the merits of the open circuit type, including the hedgehog. The hedgehog transformer, however, was not invented in 1885. Mr. Stanley assumes that the primary current of the hedgehog transformer does not decrease with the load, or that it decreases, at most, 20 per cent. This may be the case with the early form of Gaulard and Gibbs transformers, but is not true of the hedgehog. The exciting current at no load is about one-third of the full load current. Taking, now, Mr. Stanley's example, we may take a station with the full load output of 10,000 lamps and 10 engines and dynamos. Taking 95 per cent. as the full load efficiency of the transformers, whether open or closed, and omitting loss in leads, we have 525,000 watts supplied to the terminals of the dynamos. Assuming efficiencies of 90 per cent. for the dynamos and engines, we have 583,000 watts supplied to the pulleys and 648,000 watts indicated. If all the lamps are turned out, one engine and dynamo can run all the closed circuit transformers. There is then a waste of 25,000 watts in the iron, the waste in copper being taken as inappreciable; there is a loss of 5,800 in the dynamo and 6,500 in the engine, making a total waste of 37,400 watts.

Taking, now, the case of the hedgehog. At no load the loss in iron is about 5,000 watts, and three dynamos can supply the exciting current. As very little power is needed, it is not necessary to run three engines. Nine engines and seven dynamos are, therefore, shut down altogether, and two dynamos are left running with the engines, uncoupled by friction or other clutches, and one engine supplies the power. We thus have one engine driving one dynamo directly, and two other dynamos running loose as motors and supplying the exciting current. The total loss is, then, 5,000 watts in the iron of the transformers, 17,400 watts in three dynamos and exciters, and 6,500 loss in one engine, making a total of 30,000 watts. So, even in this clumsy way, the loss in the hedgehog type comes out less than in the closed circuit type, instead of 7.6 times as great, as Mr. Stanley makes it. I must point out, however, that if the transformers had to be run all day with no load, a 50,000 watt engine would not be used to drive, as only 5,000 watts are used in the transformers.

This method is only one way of running open circuit transformers. We have not yet had any trouble from exciting current, and when we do, we will merely provide condensers to supply the exciting current. It is then necessary in the previous example to run one engine of 6,200 watts, and one dynamo giving 5,000 watts on the terminals. The loss with the closed circuit transformers thus comes out six times as great as the loss with the hedgehog, instead of being about an eighth, as Mr. Stanley makes out. Even this comparison is not quite fair, as the efficiency of 95 per cent. for the closed circuit is higher than is generally obtained in practice. The Westinghouse Company, for instance, advertises the efficiency of three leading American makers as below 90 per cent.

They except their own, but they may be biased with regard to it. There is no reason why they should have any monopoly of high efficiency in closed circuits, as any other maker can use good iron and follow the principles laid down in my British Association paper. I am quite aware, of course, that a scientifically designed closed circuit transformer can give 95 per cent. efficiency; but advocates of closed circuit transformers should do me the justice to admit that this high efficiency is not due to them. Until my paper was read at the British Association, in 1888, little was thought of the loss in iron. I there showed how closed circuit transformers should be designed to give 95 per cent. efficiency; and since then makers have reconsidered the proportions of the iron and copper in their transformers. As far as I know, nothing had been said before about proportioning the iron so as to get small loss by hysteresis. The high efficiency closed circuit transformers have been produced by following the lines indicated in my paper. I am, therefore, hopeful that electricians will eventually go still farther, and fully realize the value of the hedgehog transformer.

JAS. SWINBURNE.

Wimbledon, England.

THE MOST ECONOMICAL ARRANGEMENT FOR ELECTRO DEPOSITION.

In reply to Mr. C. O. Mailloux's remarks under the above heading, appearing in your issue of Feb. 18, I must acknowledge that I can still see no advantage to be derived from his "live" resistance, which must vary with every change of current, instead of representing the term counter-electromotive force in its simplest and true light—a constant. The method suggested by him in obtaining his "live" resistance, in order to get the term ε in the equation $E = C(R + r) + \varepsilon$, is impracticable. He says: "From the potential difference at the terminals of the vat and the current passing through the vat, we obtain $\frac{E}{C} = R + \rho$. We then measure the ohmic resistance R and subtract its value from $(R + \rho)$; or, $\frac{E}{C} - R = \rho$." In electrolytic refining of copper, $R = .001$ ohm, is a large value for the resistance of a vat. Measuring such a resistance by a resistance method without the most perfect and delicate laboratory instruments, perfect contacts and calibrated connection pieces, is, of course, out of the question, leaving out of consideration the effect of even a minute electromotive force upon the measurement of so small a resistance. Besides, the conditions under which the observations were made would not be the same.

Mr. Mailloux calls attention to the "almost humorously" high voltage which I mention (about 75 volts). I do not know to what plant he refers when he says that, "The presumably oldest and largest copper refining firm in this country has for years used, and, so far as is known, is still using, machines of over 4,000 amperes with an E. M. F. of 15 to 20 volts." The largest plant in this country of which I have any knowledge refines over 17 tons of copper per day, using an E. M. F. of 135 volts. Another large copper refinery, having a generator capacity of over 140 kilowatts has 60 volt machines. Of course with small plants of only 35 or 40 vats it is impossible so use anything but a low voltage, on account of losses by the decomposition of water.

Since the plan which I propose—of using the moderate voltage of "about 75 volts" in large plants and connecting the vats in single series—has been so attacked, I have taken the trouble to look up the latest practice abroad. The latest London *Electrician* (February 6, 1891) speaks of one of the dynamos used in the new Elmore Works, near Leeds, as having an output of 750 amperes at 50 volts, and, nothing being said to the contrary, the others have presumably the same voltage. I also find in Gore on "Electrolytic Separation of Metals," edition of 1890, p. 182: "The arrangement of a number of small vats in series is preferable, because with a small number of large ones in series and a current of low electromotive force, any increase of resistance in the vats, or any cross circuiting has much more serious effects than with a larger number of vats and a current of higher electromotive force." It seems to me that this stands to reason. Also in other places, the electromotive force in use in the North German Refinery, Hamburg, is given as 54 volts; at Pembroke, England, 110 volts; at Ponte Sto. Martino, Piedmont, 120 volts, and so on. From the above I think that the latest, and presumably best, practice will be found to uphold my ideas.

I regret that Mr. Mailloux should have thought that I did not give him due credit. It was certainly through no intention on my part to underestimate his interesting articles, and I treated, naturally, of the points on which I disagree with him.

GILBERT WILKES.

NEW YORK, Feb. 20, 1891.

W. A. CADUGAN, of the Edison Company, is constructing several plants in the southern part of Pennsylvania, with headquarters at the Martin Building, Pittsburgh, Pa.

Home Correspondence.

BOSTON.

An Underground Road for Boston.—A Rapid Transit Commission Wanted.

AT the State House a continued hearing was given to Mr. H. C. Spaulding for authority to construct an underground railway in this city. Mr. Woodward Emery, in behalf of Mr. Spaulding, stated that the object of the road was to connect the railway stations of the city rather than to take care of the outlying sections, so that the surface roads would not be much interfered with.

The subject of the regulation and control of electric wires was also discussed before the committee on mercantile affairs. Representative Stearns, of Salem, spoke in favor of having these wires under the control of proper authorities. A bill was presented to the committee providing for a board that should have control of the use of electric wires, the granting of locations and licenses, and charging fees for each new pole erected.

At a meeting of the Board of Aldermen, a statement was received from Inspector of Wires Brown S. Flanders, showing that $11,707.07 is needed for salaries from Dec. 1, 1890, to May 1, 1891, and that he has only $849.70 for the current running expenses during the same time. This makes the $12,556.77 that was transferred to his department from the fire department.

At a meeting of the Common Council the aldermanic order was passed that the mayor be requested to appoint three persons, who, with the mayor and city engineer, ex-officiis, shall constitute a commission to consider the subject of rapid transit and quicker communication between the city proper and the outlying districts and suburban towns and cities.

BOSTON, Feb. 28, 1891.

PITTSBURGH.

New Plant for the Allegheny County Light Co.—The Schenley Park Electric Railway.

THE power house of the Allegheny County Light Company, which is now situated in Virgin alley, this city, will shortly be removed to a more convenient location. The company recently purchased a site on Etna and Twelfth streets, a part of the Bradley estate, and here a new plant will be immediately erected. The new site is three hundred by one hundred feet, and it will give the company an opportunity to put up a building that will hold enough electrical machinery to make it probably the largest electric lighting plant in the world. The company has for some time been in very close quarters, in the old power house. The enormous demand made upon its capacity caused the building to become very crowded. The Allegheny County Light Company operates the Westinghouse alternating current system and has now a capacity of 35,000 incandescent and 1,000 arc lights, and if the company were able to satisfy the demand made upon it by the public, it would be necessary to increase the plant at the rate of about one thousand lights a month. This, however, is impossible under the present circumstances, because the old plant will not hold any more apparatus conveniently. In the new building, however, the company expects to be able to place enough electric lighting machinery on one floor to furnish over 100,000 16 c. p. incandescent lamps. The old buildings are now in the market, and it is expected that the removal will have been completed by next October.

PITTSBURGH, Feb. 27, 1891.

College Notes.

COLUMBIA COLLEGE.

DR. M. I. PUPIN, Instructor of Mathematical Physics in the Department of Electrical Engineering, of Columbia College, began on Feb. 21st, a course of university lectures "On the Principle of the Conservation of Energy and its Application in Physics and Chemistry." These lectures are delivered on Saturdays, from 11 to 1.

KIND WORDS FROM GERMANY.

A leading American and German electrical company with headquarters at Hamburg, writes us as follows from that city, under date of February 9, with regard to their subscription, which they had allowed to lapse through oversight: "We have not received our copy of your esteemed journal for some time, and would like to know whether our subscription has run out, or if some mistake has occurred. In any case, please continue where you left off, as we regard your journal the most valuable of all the technical journals in this office of which we have very many, and in five or six languages."

Reports of Companies.

MATHER ELECTRIC COMPANY.

At a meeting of the stockholders of the Mather Electric Co., Manchester, Conn., the following officers were elected: President, H. G. Cheney; vice-president, M. S. Chapman; secretary and treasurer, R. Cheney; general manager, N. T. Pulsifer; electrician, W. A. Anthony.

SOUTHERN MASSACHUSETTS TELEPHONE CO.

At the annual meeting of the Southern Massachusetts Telephone Co. the following officers were elected: President, C. W. Clifford; clerk and treasurer, S. Ivers; directors, C. W. Clifford, O. P Brightman, W. Clifford, M. Rotch, M. E. Hatch, S. Ivers, W. H. Forbes, T. Sherwin, S. W. Knowles.

An annual dividend of 8 per cent. is now payable.

THE EICKEMEYER-FIELD CO.

The above company has been formed with a capital stock of $1,000,000. Rudolph Eickemeyer is the president; S. Shethar, vice-president; E. A. Nichols, treasurer. The company proposes building electrical apparatus and appliances under the patents of Rudolph Eickemeyer and Stephen D. Field. The Eickemeyer factory is now being enlarged for the work to be done.

THE WIDDIFIELD BRAKE.

Mr. Watson P. Widdifield, of the Widdifield Electric Brake Co. (Limited), Toronto, Canada, having sold his U. S. patents, has gone to Europe to dispose of his patents in Great Britain, France, Germany, Spain, Italy, Belgium, Austria-Hungary, India and Russia.

ELECTIONS.

The Greenfield, Mass., Electric Light Co., at its annual meeting, elected the following officers: President, H. W. Warner; secretary, C. H. Keith; treasurer, F. E. Pierce.

The Webster (R. I.) Electric Light and Gas Co. has elected the following officers: N. T. Hurlburt, president; L. E. Pattison, secretary; J. S. Gould, treasurer; with a board of five directors.

Canastota, N. Y.—The stockholders of the electric light company have elected W. H. Patten, secretary and treasurer, to succeed W. H. Tuttle. George Tibbits was elected superintendent.

Brattleboro, Vt.—The annual meeting of the Vermont International Telegraph Company was held recently at St. Johnsbury. These officers were re-elected: President, Franklin Fairbanks; secretary, George W. Hendee; superintendent, E. A. Silsby.

Helena, Mont.—At a meeting of the board of trustees of the Helena Electric Co. the following officers were re-elected: President, C. W. Cannon; vice-president, H. M. Parchen; secretary and treasurer, H. L. Walker.

Meadville, Pa.—At the annual meeting of the People's Incandescent Electric Light, Heat and Power Co., Meadville, Pa., the following officers were elected for the ensuing year: President, Dr. Cyrus See; vice-president, C. Fahr; secretary, F. R. Shryock; treasurer, J. Reitze, Jr.

Utica, N. Y.—The stockholders of the Electric Light Company have elected the following trustees: H. D. Pixley, R. T. McDonald, W. E. Lewis, Joseph F Blaut, T. Solomon Griffith, H. M. Schench, M. J. Brayton. The trustees elected the following officers: H. D. Pixley, president; R. T. McDonald, first vice-president; W. E. Lewis, second vice-president; M. J. Brayton, secretary and treasurer.

STOCKS AND BONDS.

Jenkintown, Pa.—The stockholders of the Jenkintown, Pa., Electric Light Company, are considering the advisability of increasing the capital stock of the company from $40,000 to $100,000.

Worcester, Mass.—A mortgage for $350,000, given by the Newburyport and Amesbury Street Railway Company, to the International Trust Company, of Boston, has been recorded in the town clerk's office, in Merrimac.

DIVIDENDS.

Eastport, Me.—The Eastport Gas and Electric Co. has declared and paid a dividend.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Council, on February 24, the following gentlemen were elected to associate membership:

Anthony, Watson G.—Assistant Electrician. The Okonite Co., 32½ Webster street, Newark, N. J.
Gordon, Reginald.—Assistant in Physics, Columbia College, New York City. Residence, 76 Park avenue.
Laudy, Louis H.—Assistant in Applied Chemistry, School of Mines, Columbia College, New York City. Residence, 289 West Fifty-second street.

The evening was devoted to a paper by Mr. O. T. Crosby, of Boston, on the results of his work in electric traction at 120 miles an hour, with the Weems system, at Baltimore. There was a brisk discussion. Mr. F. L. Pope described and exhibited the model electric railway, recently found by himself during his researches for the biographical sketch of Thomas Davenport in The Electrical Engineer. The attendance at the meeting was very large.

CHARLES E. EMERY TO LECTURE BEFORE THE NEW YORK ELECTRICAL SOCIETY.

The next lecture before this Society will be given at Columbia College School of Mines, on the evening of Friday, March 6th, by Charles E. Emery, Ph.D., the well known engineer, on the subject of "The Utilization of the Forces of Nature." This lecture will be remarkably well adapted to interest both a popular and a technical audience. Starting with a brief classification of the various known forces, the speaker will advert to the various familiar phenomena which produce currents of air and of water; refer to the storage of energy in fuel, due to the action of natural forces in former ages; illustrate on the screen a tornado, a lightning flash and the effects of winds and storms on trees and buildings; show various views of wind mills, including examples of those used for draining the Holland polders, contrasted with those of American construction, and describe briefly the principles of regulation of various wind mills. The subject of water power will be treated exhaustively, with illustrations of different kinds of water wheels, notes as to the relative efficiencies, an explanation of the principles of the turbine, interspersed with views of waterfalls, glaciers and references to important works and means employed to transmit the forces and utilize the same at a distance. The methods of utilizing the energy stored up in fuel will be illustrated by several examples of land and marine steam engines and of steamers of the merchant and naval marine. It is proposed to curtail the remarks in relation to the application of electricity as being already familiar to the audience, and instead thereof to discuss the relative efficiencies of the different means available for utilizing the energy of natural forces and show the applicability of each for particular purposes. The evening, in short, promises to be one of the most useful and interesting ever enjoyed by the Society.

Appointments, Etc.

Mr. J. A. Smiley has succeeded Mr. O. B. Conlin, as superintendent of the Electric Light Company, of Orangeburg, S. C.

Mr. T. C. Frenyear has accepted a position with the Edison General Co., and will represent it in New York State, giving special attention to the railway department.

Mr. M. D. Law, late of the Denver, Col., Consolidated Co., and of the Brush Co., of Philadelphia, has been placed in charge of the arc light department of the Edison machine works, at Schenectady, N. Y., where he will have charge of the output, &c.

Mr. A. P. Wilkes has been appointed superintendent of the electric lines in St. Paul.

Electrician Wells has been appointed superintendent of the Auburn City Railway Company, of Auburn, N. Y.

William E. Smith, of Allentown, Pa., has been appointed assistant to Manager Lerch, of the Reading telephone district.

U. S. ELECTRIC RAILWAYS CO.

Mr. R. S. Brown, the agent of the railway department of the Westinghouse Co. in New England, has just closed a contract for the Biddeford, Saco and Old Orchard Beach road. The U. S. Electric Railways Co., of this city, will do the construction.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEB. 17, 1891.

Accumulators:—

Secondary Battery, A. M. F, Laurent-Cely, T. A. Timmis, 446,527. Filed Apr. 8, 1890.

Has for its object the production of plates of much less density and more storage capacity than those previously made.

Alarms and Signals:—

Annunciator, J. H. Elfering, 446,641. Filed Apr. 24, 1890.

Relates to improvement in that class of hotel annunciators in which the room from which a guest is calling is not only located, but also the specific want of the guest made known in the office and visually displayed there until it has been noted by the clerk.

Electric Call-Bell, D. H. Rice, 446,713. Filed Nov. 16, 1881.

Consists in applying to a Currier bell an automatic circuit breaking device working in the time of the vibration of the hammer of the bell, and so adjusted as only to be set in action when the bell hammer has reached its amplitude of vibration.;

System of Electric Calls, J. B. Currier & D. H. Rice, 446,732. Filed Nov. 18, 1888.

Invention consists in providing a circuit-breaking calling mechanism with a shunt circuit and a key or other like device to send a current through the magnet and around the circuit coil, together with other details.

Clocks:—

Electric Regulating-Clock, D. Van De Plancke & G. Van De Plancke, 446,801. Filed May 21, 1889.

Invention consists of a new system of electric regulating for clocks, in which the instantaneous closing and breaking of the electric circuit has the double effect of sending intermittent currents to different receiving dials and at the same time winding the regulator itself.

Dynamos and Motors:—

Commutator and Brush, H. F. Parshall, 446,536. Filed July 30, 1890.

Claim follows:

In a reversible electrical machine or motor the commutator provided with bars or sections with wires of the armature, in combination with a pair of brushes arranged thereon with opposite inclinations and making sliding contact with same bar or section of the commutator.

Electric Fire-Engine, M. W. Dewey, 446,703. Filed July 7, 1890.

Has for its object to electrically propel an electric fire engine to and from the fire so that it will not be necessary to employ horses for this purpose.

Galvanic and Thermo-Electric Batteries:

Battery Compound, W. Wright, 446,544. Filed May 12, 1890.

Has for its object to provide an electrolyte for primary and other batteries, whereby electromotive force of any desired intensity may be secured at a lower cost than has hitherto been obtained.

Pyro-Chemical Battery, J. Blair & A. J. Hunter, 446,727. Filed June 25, 1890.

Invention consists of a cell containing a series of composite plates each formed of an iron plate separated from a carbon plate by prepared absorbent septa or partitions, the chemically active plates being connected by a wire with the chemically passive plates in the successive composite plates in the usual manner; the chemical transfer of the elements being caused by the application of heat.

Lamps and Appurtenances:—

System of Electric Lighting, T. A. Edison, 446,666. Filed June 26, 1882.

Has for its object to produce an efficient means for supplying with current incandescent electric lamps, motors and other translating devices arranged in multiple arc, and for utilizing a current of high tension in the main conductors so as to reduce the investment for copper in such main conductors.

Electric Arc Lamp, J. A. Mosher, 446,459. Filed July 8, 1890.

Details of feeding and braking or arresting mechanism.

Moisture-Protection Hood for Lamps, A. Shillinglaw, 446,477. Filed May 22, 1890.

Detail of attachment and support of hood.

Disc Carbon Holder for Electric Lamps, E. C. Russell, 446,549. Filed May 14, 1890.

The invention consists of a spindle having a screw threaded enlargement and a conical projection and a split thimble, the rear end of which is threaded to fit the screw on the spindle.

Carbon for Electric Lamps, W. H. Burns, 446,660. Filed July 26, 1890.

Claim as follows:

A carbon for electrical purposes composed approximately of 90 parts of triturated, purified maltha coke and 10 parts of semi-liquid purified maltha thoroughly incorporated therewith.

Electric-Arc Light, T. A. Edison, 446,668. Filed Aug. 7, 1882.

Has for its object to produce simple and sufficient means for regulating the feed of the upper or positive carbons in arc-lamps.

Manufacture of Filaments for Incandescent Electric Lamps, T. A. Edison, 416,669. Filed March 16, 1888.

The filament is formed of a number of filaments massed together, the resulting filament being equal in size and mass and integral throughout its entire length.

Detachable Ceiling Block or Bracket for Electric Lamps, H. C. Wirt, 446,826. Filed Oct. 29, 1889.

Relates to electric cut-outs of that class in which a cap or rosette is detachably secured to a base and has for its object to effectively combine with the said cap or rosette a bracket to which one or more incandescent lamps may be secured.

Measuring Instruments:—

Electrical Measuring Instrument, E. Weston, 446,489. Filed Mar. 17, 1888.

Utilizes the principle that when a continuous body of diamagnetic metal is suspended between the poles of a magnet, it finds in the field of force a powerful resisting medium which opposes any motion and speedily brings it to rest.

Electrical Measuring-Instrument, E. Weston, 446,491. Filed May 12, 1890.

Consists of a stationary coil, a vibrating or oscillating coil supported in the field of force of said stationary coil, a means of indicating the extent of movement or deflection of such movable coil, and a spring opposing the motion of said vibrating coil.

Electrical Measuring-Instrument, E. Weston, 446,492. Filed July 1, 1890.

Combines in a measuring instrument a primary conductor, a secondary conductor, and two coils included in said secondary conductor, one of said coils being movable in the field of the other.

Electrical Measuring-Instrument, E. Weston, 446,493. Filed Oct. 14, 1890.

Details of design and construction for measuring the difference of potential between its terminals.

Electrical Measuring-Instrument, E. Weston, 446,494. Filed Oct. 16, 1890.

Potential instrument. Novelty in design and construction.

Medical and Surgical:—

Magneto-Electric Machine, G. P. Clarke, 446,661. Filed Aug. 23, 1890.

Claim as follows:

An electrical casket having in combination with the enclosing case, the main shaft actuating spring or springs. connected armature magnet and circuit breaker, and a permanent hand electrode. The removable hand electrode electrically but loosely connected with the driving shaft.

Metallurgical:—

Amalgamating Apparatus, T. Gemmell, 446,706. Filed Dec. 12, 1889.

Claim follows: In an amalgamator, a mercury holding vessel, a pipe extending within the said vessel to near its bottom to convey ore from a point exterior to the vessel to a point below the contained mercury, the lower end of said pipe being flaring and upwardly turned. A porous cell supported by the upturned portion of said pipe, and an electrolyte and an anode in the porous cell combined with an electric generator and wires leading from the opposite pole of the generator to the anode and the mercury.

Induction Coil, F. H. Brown, 446,780. Filed July 21, 1890.

Consists of a battery combined with an induction coil for the purpose of locating and detecting mineral ores, by placing the discharges of the induction coil in contact with rock supposed to contain metals.

Magnetic Ore-Separator, C. G. Buchanan, 446,767. Filed Feb. 25, 1890.

Claim follows: In a magnetic ore separator a hollow cylinder of alternating segments of magnetic and non magnetic material. A series of electro-magnets arranged to polarize the magnetic portions of the cylinder, and means for reversing the polarity of the electro-magnet.

Miscellaneous:—

Electro-Magnetic Cut-Out, L. Gutmann, 446,515. Filed Feb. 4, 1890.

Has for its purpose to automatically connect or disconnect a dynamo or motor or any other apparatus to or from the main line, but especially when it is in circuit with alternating intermittent or pulsating currents of high electromotive force.

Electric Lock, 446,509, E. J. Colby, Filed May 6, 1890.

For the protection of valuables.

Rheostat, E. Weston, 446,490. Filed Feb. 28, 1889.

Relates to an instrument having for its object the interposition of a desired electrical resistance in a circuit, the determination of a resistance the magnitude of which is unknown, and the finding of the difference of potential between two points of a circuit.

Electric Music-Box, C. A. Hussey, 446,684. Filed Dec. 29, 1888.

Claim 1 as follows:

The combination with a music box comb and a pin cylinder, of an electro-motor for rotating the pin cylinder, a lever controlled by one of the moving parts of the music box mechanism. and serving to operate a circuit breaker or closer, and a cam acting on said lever.

Electric Heater, T. J. Donovan, 446,831. Filed Jan. 20, 1890.

Relates to the heating of fluids and the generation of steam by electricity.

Glassware, X. Zgraggen, 446,590. Filed June 23, 1890.

Claim as follows:

A hollow article of glassware whose interior surface is lined with a compound metallic coating consisting of a chemically deposited metal film next to the glass, and an electro deposit of metal which backs and protects said film.

Railways and Appliances:—

Electric Railway Signal, W. S. Cook & M. C. Cook, 446,546. Filed Nov. 16, 1889.

An electric system of danger signalling for railways whereby the engineer of the train will be notified in time to stop his train before it is too late. Also an improved system of telegraphing or signalling from one train to another or from a train to a station.

Conduit Electric Railway, E M. Bentley, 446,417. Filed Oct. 13, 1887.

Invention relates to electric railways in which the main supply conductor or conductors are enclosed in a slotted conduit and consists in an arrangement of line conductors for switching and crossing.

Electric Line Switch. E. M. Bentley, 446,418. Filed Feb. 15, 1890.

Relates to an overhead line conductor which is divided into sections, and consists of a switch for connecting the sections attached directly to the line conductor.

Contact Device for Electric Railways, E. M. Bentley, 446,420. Filed July 11, 1890.

Adapted to maintain a traveling electric connection with a supply conductor located in a slotted conduit.

Contact Trolley for Electric Railways, J. B. Cahoon and I. F. Baker, 446,428. Filed July 3, 1890.

Provides an automatically detachable contact maker upon a trolley-pole of usual construction.

Electric Railway, N. Siebert, 446,475. Filed May 5, 1890.

Designed to provide a simple means for facilitating the rounding of curves and a mechanism whereby the main truck frame is permitted to have a lateral motion to accommodate the side movement of the car.

Electric Railway Conductor, E. Thomson, 446,483. Filed March 22, 1890.

Consists of an improved method of supporting the trolley wire, in supplying the same with current, and in protecting it from short circuits or grounds caused by the falling upon it of other wires.

Controlling Switch for Electric Railways, F. B. Rae, 446,613. Filed Aug. 22, 1890.

For storage-battery cars.

Locomotive for Electric Railways, T. A. Edison, 446,667. Filed Aug. 7, 1882.

Claim 1 follows:

The combination of a car or truck and electric motor mounted thereon, a countershaft having pulleys, a tight belt from the armature shaft to said countershaft, and a loose belt from said countershaft to car, and a belt tightener for the latter belt.

Electrically Propelled Car, R. M. Hunter, 44'.817. Filed March 14, 1889.

Claim 1 follows:

A car having longitudinally arranged seats, end dashers, openings in one of the car body ends and in the dasher adjacent thereto in line with the spaces below said seats, and doors or covers for said openings in the car end and dasher for effecting the transfer of the storage batteries to and from the car.

Electric Locomotive, E. M. Boynton, 446,821. Filed Oct. 17, 1890.

Relates to means for connecting the armature shaft of an electric motor directly with the driving wheel of a bicycle or other vehicle without intermediate gearing.

Electric Railway, R. M. Hunter, 446,833. Filed March 16, 1888.

Has for its object to provide a suitable construction adapted to overhead conductors whereby strength, durability, simplicity, and low resistance result with cheapness of construction.

Electric Railway, R. M. Hunter, 446,834. Filed June 4, 1889.

A system of distribution for electric railways, in which there are employed extensive line or working conductors, the generator or generators being connected with different parts of the same circuit by suitable feeding wires.

Electric Railway Conduit, E. M. Bentley, 416,419. Filed April 9, 1890.

Relates to an electric railway in which the supply conductor is enclosed in a separate conduit beneath the surface of the road, and consists of certain means for supporting and insulating a conductor within a conduit of special construction.

Telegraphs :—

Telegraphy, R. G. Brown, 446,424. Filed Mar. 6, 1886.

Relates to "synchronous telegraphy" or "synchronous multiplex" telegraphy, and especially the Delany system.

Telegraphy, R. G. Brown, 446,425. Filed Mar. 6, 1886.

Claim 1 follows: The described method of transmitting messages in either direction at will over a single main line connecting two or more multiplex synchronous telegraph apparatus, consisting in causing thet ransmittin gimpulses to be set up over the wire where the receiver is disconnected therefrom. and receiving such impulses through the receiver while the transmitting generator is disconnected therefrom.

Telephones and Apparatus :—

Telephone-Call, D. H. Rice, 446,614. Filed Oct. 15, 1881.

Claim 1 follows:

In combination with a number of electrical circuits provided with individual call bells thereon adapted to be operated by synchronous pulsations of electricity, lines adapted to connect each circuit with a different number of cells of electric batteries, and a vibrating calling mechanism adapted to transmit synchronous pulsations of electricity to ring one or more of said bells.

Electric Switch, G. R. Lean, 446,623. Filed May 12, 1890.

A "quick acting" or "jump" switch and especially designed for multiple arc lighting.

Electric-Conductor Connection, H. Arld, 446,655. Filed Sept. 15, 1890.

Relates to improvements in terminals or binding posts for electrical circuits.

Magnetic Pulp-Separator, W. C. Edwards, 446,704. Filed Sept. 29, 1890.

Relates to separators for separating metallic particles from paper pulp by means of ordinary permanent magnets.

Patent Notes.

AN OFFICE DECISION IN FAVOR OF GAULARD AND GIBBS.

The patent of Gaulard and Gibbs of October 26, 1886, for a system of electrical distribution by alternate currents and converters, which is regarded as one of the fundamental patents of the Westinghouse Company, has been the subject of protracted interference proceedings in the Patent Office for several years past, prior invention having been claimed on behalf of two interfering applications, filed respectively by Rudolph M. Hunter, of Philadelphia, and Deprez and Carpentier, of Paris. Commissioner Mitchell has now rendered a decision affirming the priority of Gaulard and Gibbs as against both of the contestants.

THE SLATTERY-STANLEY INTERFERENCE.—DECISION FOR STANLEY.—PARALLEL DISTRIBUTION BY ALTERNATING CURRENTS.

It will be remembered that in 1887, the Westinghouse Electric Co. brought an action under the Gaulard and Gibbs patent of 1886, against the Sun Electric Co., of Woburn, Mass., alleging infringment of the claims for a potential reducing converter system of distribution by alternating currents. The suit was finally defended by the Fort Wayne Jenney Company, who had meantime secured control of the Sun Co., and was decided in favor of the defendant, mainly on the ground of non-infringement, the patent showing the converters in series, while in the alleged infringement the converters were placed in parallel. Slattery, in behalf of the Fort Wayne Co., then made application for a patent on April 5, 1888, which was granted on July 31, following, the claims of which covered, in substance, any parallel system in which the counter-electromotive force in the converters is practically made equal to the direct electromotive force when the secondary circuits are open, which is, of course, an essential condition in all systems of multiple arc distribution by alternating currents. Immediately after the issue of this patent, an application, claiming the same thing, was filed by William Stanley, Jr., on behalf of the Westinghouse Co., who proved that he had experimentally operated a plant involving the invention, at Great Barrington, Mass., early in the spring of 1886. Interference proceedings were instituted which have been prosecuted with great vigor on behalf of both contestants. The Examiner of interferences and the Board of Examiners-in-Chief both decided in favor of Stanley, and we now learn that Commissioner Mitchell, on appeal, has affirmed the decision of the lower tribunals, which terminates the controversy in favor of Stanley and permits his patent to issue.

Legal Notes.

A $200,000 SUIT AGAINST THE WENSTROM CONSOLIDATED CO.

Chadbourne, Hazelton & Co., of Philadelphia, the general agents for the United States, for the Wenstrom Consolidated Dynamo and Motor Co., of Baltimore, have brought suit againt that company in the sum of $200,000 for commissions due and breach of contract. The claim is based on the alleged inability of the firm to fill electric railway contracts because they could not get the apparatus from the manufacturing company. As we go to press we have received from Chadbourne, Hazelton & Co. the following open letter, in which they present their case. The item from the Philadelphia *Times* enclosed gives the information of the above nature, and need not be quoted:

> In connection with the enclosed article from the Philadelphia *Times* of February 27, we want to say a few words in explanation.
>
> About a year ago, the Wenstrom Consolidated Dynamo and Motor Co. was organized in Baltimore, being the outcome of a consolidation known as the Wenstrom Northern and Wenstrom Southern Electric Companies.
>
> The officers and Board of Directors of the Wenstrom Company were such well known men, that it seemed unnecessary to question very closely into the details of the organization. Mr. Tunis, the president of the company, came to us, and negotiations were commenced, whereby we should take the general agency of the company. He impressed upon us most forcibly, the financial, political, and social standing of his Board of Directors, and assured us that the company would have unlimited backing from them and that there was sufficient money forthcoming to put the company in the foremost ranks of the electric companies, and it lay with us to make it a success.
>
> We gave the matter careful consideration, and thoroughly believed that we were to represent an electric company that would be the rival of any company in the country. It takes a good deal of money to run a successful electric company, and it takes a good deal of push, and hard work and energy. We were prepared to supply the latter, and expected the Wenstrom Company to provide the capital to manufacture their apparatus.
>
> As is generally known, we accepted the general agency for the United States and organized a selling department with about 15 sub-agencies throughout the United States in the principal cities, and we started in to work under what we believed to be the most promising circumstances. Nearly a year has passed, and on looking over our records, we find that only about 5 per cent. of our orders accepted by the Wenstrom Company for dynamos and motors have been filled.
>
> Only a few days ago we announced the closing of an important railway contract in Denver, Colorado, some 14 miles of track and various heavy electric locomotives and car equipments, and also a contract in Athens, Ga., and orders for equipments on several other roads. All these contracts and orders were accepted by the Wenstrom Company, but within the last few days it has become apparent that some of the most important at least they will be unable to fill, so that the railway contracts which include the overhead construction, amounting to about $225,000, will probably be equipped with some other system.
>
> We have been promised time and time and again that the company would be on its feet and that the work would be pushed and that goods would be delivered. But the time has come when we can no longer wait, and we feel that we have already injured ourselves in the eyes of our customers and the electric world by the repeated promises which we have made and been unable to fulfill. Outside of the large pecuniary loss to ourselves, we feel most deeply the humiliating position in which we have been placed. We have received kind and encouraging words from our many friends in the business, and from the various journals who have offered their columns to us, and we wish them to understand that we have been misled.
>
> Mr. Hazelton and myself, feel that the time has come when we must take a stand. While we can't undo the harm that has been done, yet we are more desirous of placing ourselves straight before the people with whom we have been dealing than anything else. It is unnecessary to say that we shall stick to the "electric" business, and while we have not the most remote idea, as to what our future steps will be, yet we are sure of one thing, that if we ever undertake to represent any company or attempt to close any contracts for the delivery of any kind of apparatus, electrical, or otherwise, we will assure ourselves that we can deliver it witnin a reasonable time.

Obituary.

T. P. CONANT.

The death last week, on Feb. 24, of Thomas P. Conant, was a cause of great surprise and grief to electrical engineers in this city and elsewhere. He had been ill some time and succumbed at last to rheumatism of the heart. Mr. Conant was born in Paris in June, 1860. He was educated at the Columbia School of Mines, from which he was graduated in 1882. He then became Mr. Thomas A. Edison's secretary, and made rapid progress in electrical engineering. He was for a while actively connected with the Electrical Accumulator Co., of this city, both here and in Chicago. At the time of his death he was engineer for the Eastern district, comprising this state and a part of New England, for the Edison General Electric Co. Mr. Conant was a member of the Manhattan Athletic Club, the Electric Club, the American Institute of Electrical Engineers, and numerous other electrical and engineering societies. His funeral was held Friday at the home of his grandfather, the Rev. Dr. T. J. Conant, Washington street, Brooklyn. The Rev. Dr. Lyman Abbott conducted the services.

DR. N. AUG. OTTO.

We regret to record the death of Dr. N. Aug. Otto, the inventor of the celebrated Otto gas engine, who succumbed to a brief illness, at Cologne, Germany, on January 26, and whose career exemplifies the success of perseverance and energy, coupled with ingenuity and skill. Dr. Otto was an honorable man, esteemed by all who knew him, and, though not trained as an engineer, he made himself one by hard work and study. His achievements abundantly prove his great theoretical knowledge, mechanical dexterity, and fertility of resources.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Brisk advertising of your goods is a sign of life, constant activity, springtime and a rising tide of prosperity."

THE ONGLEY ELECTRIC REGISTER AND SAFETY SIGNAL.

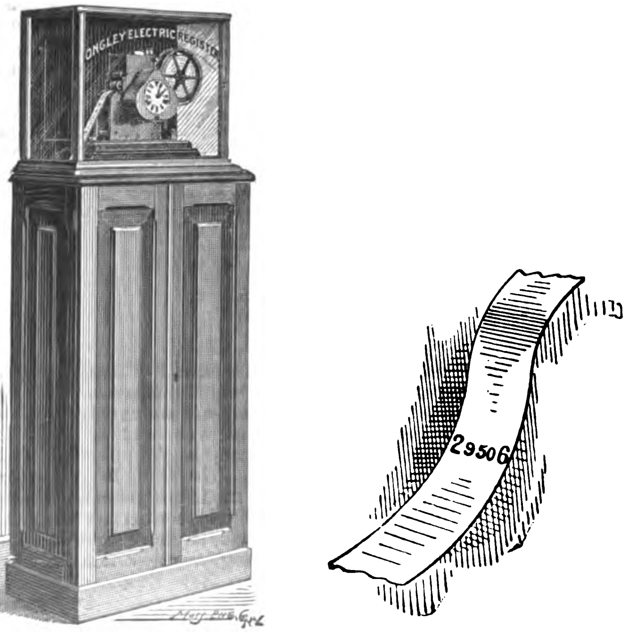
An automatic safety signal system, which will record in print any neglect of the night watchman, give a prompt alarm in case of fire, and enable the engine to be immediately stopped from any distant point, independently of the engineer, will command the attention of all owners of factories, hotels, and other large buildings in which the faithful services of a watchman are essential.

All these valuable qualities are possessed by the Ongley Electric Register shown in the accompanying illustrations.

The register, shown in Fig. 1, prints upon a strip of paper the time at which a watchman reaches any station in his rounds, together with the number of that station; for instance, the slip shown in Fig. 2 puts upon record the fact that the watchman reached station No. 26 at 9:50. If the clock should stop, or be damaged, the number of the station would still be printed, and the time omitted.

The station apparatus shown in Fig. 3 consists of an iron box, resembling a messenger call, the handle resting normally at 0; and at the top of the board, in Fig. 4, is seen the automatic recorder.

The operation of the device is as follows: If it is desired to signal the engineer to start the engine, the handle of any station apparatus is turned to "1." This means "start slow." In the two lower squares of the recorder in the engine room, immediately appear the figures composing the number of the station from which the signal was given, while the number "1" occupies the upper square. At the same time a bell rings continuously until turned off by means of the handles, which also remove the figures from the recorder, leaving the three squares empty. The register in the office, has in the meantime printed *once*, the number of the station, and the time. The handle is then placed on "2," which means "full speed," whereupon the station number appears in the two lower squares of the recorder as before, the figure "2" appearing in the upper square; the bell again rings until shut off, and the register prints the station and time *twice*. In case of fire, the handle is placed on "3," and a button at the bottom of the box is pressed. This gives the alarm in the engine room, prints the record on the register three times, and at the same time starts a special steam pump.

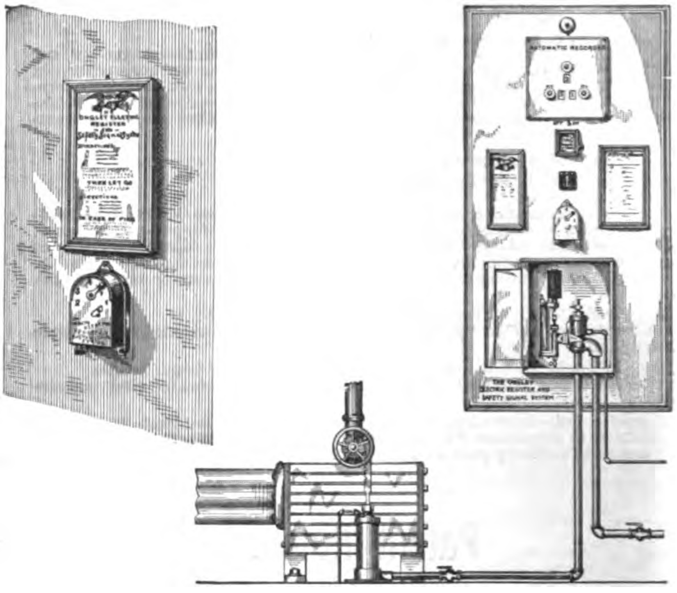


Figs. 1 and 2.—The Ongley Electric Register and Safety Signal.

To stop the engine the handle is brought upon "4." This operates, by means of an electro magnet, a small hydraulic valve, shown in Fig. 4, which, in its turn, opens a larger valve, admitting water into a vertical cylinder placed beside the steam chest. The piston rod of this cylinder terminates in a rack, which engages a gear wheel at the throttle valve, and shuts off the steam. Simultaneously the register prints the record four times, and the bell in the engine room rings until turned off, while the figures on the recorder show the station and signal number, as usual.

When the engine is not in use, the register merely keeps a record of the movements of the watchman, and also, if desired, of all doors or windows that are opened.

One of these instruments has been in use at the factory of F. J. Kaldenburg, in this city, for more than a year, during which time it has given the most satisfactory results, and has required no repairs. Here the current is supplied by twelve cells of Samson battery.



Figs. 3 and 4.—The Ongley Electric Register and Safety Signal.

The Ongley register has been approved by the New York Board of Fire Underwriters, the Philadelphia Fire Underwriters' Association, and the South Western Tariff Association, of Atlanta, Ga.

The register is manufactured by the Ongley Electric Company, of No. 1 Broadway, and is already in successful operation in a number of factories, etc., throughout the country.

CLEVERLY'S TRAITS AND TRAYS.

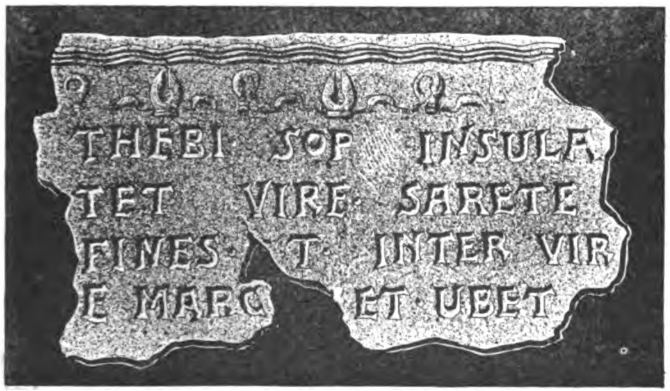
For a long time past the handsome gifts presented to his male friends by Mr. H. A. Cleverly, of Chestnut street, Philadelphia, have been greatly admired. The quiet, good taste, sound æsthetic judgment and profuse generosity of this second Franklin have been exhibited in blotting pads, calendars, thermometers and other bargain counter bric-a-brac, and the result is that to-day the name Cleverly is venerated in every office and household where it is felt that life without a chromo of some kind from him every three months would not be worth living. But Cleverly never disappoints his friends; on the contrary, he always rises superior to their expectations—except when they strike him for an "ad"—and now he once more comes forward bearing gifts. This time it is something to please the ladies of the electrical profession, and takes the shape of a magnificent cut-glass, superfine tray for preserves. The glass is of extraordinary hardness. Last week Mr. Cleverly threw a tray jocularly at the head of a persistent advertising canvasser from Chicago. It hit him on the cheek but did not break. The color of the glass is also exquisite in its purity and innocent whiteness, while the sparkle of each facet is a further delicate reminder of the donor's ceaseless play of fancy. Before retiring with the large fortune which he cheerfully and gladly admits is wholly due to his free and unstinted use of printer's ink, Mr. Cleverly wishes to make every electrical home happy with one of these trays; and he will therefore send one on application to any address on receipt of $2.25 and a stamped envelope as a guarantee of good faith. As the trays retail for $1.75 at Wanamaker's, it will be seen that Mr. Cleverly is simply trying to accumulate a fund towards meeting the expenses of his next appearance in the role of Santa Claus. Due notice will be given of that performance. Mr. Cleverly asks us to say that if the $2.25 is not remitted, he will still send the tray, and will open an account for it in case the recipient is not already in his good books.

THE UNIVERSAL ARC LAMP CO.

A significant proof of the new ideas prevalent in electric lighting was shown in the great interest taken at Providence by arc and incandescent men in the display made by the Universal Arc Lamp Co., who were represented by Mr. E. S. Mendels, the general manager. Two of the Universal lamps were displayed right in the centre of the exhibition hall on mast arms. Any weakness or failure would have had prompt and mortifying exposure, but they burned on all the time, brilliantly, steadily and noiselessly, running on a direct current of 110 volts, and consuming 8 amperes. This notable exhibit was the theme of much warm commendation as proving the desirability and availability of this mode of arc lighting for interior as well as exterior illumination, doing away with high tension wires where they would be most apt to do harm. Mr. Mendels would have talked himself hoarse answering inquiries, but for the generous provision of liquid hospitality by the good folk of Providence. and since his return home he has been unable to keep pace with the demand for information, prices, etc., from those who saw the lamps.

BISHOP WIRE AMONG THE ANCIENT ROMANS.

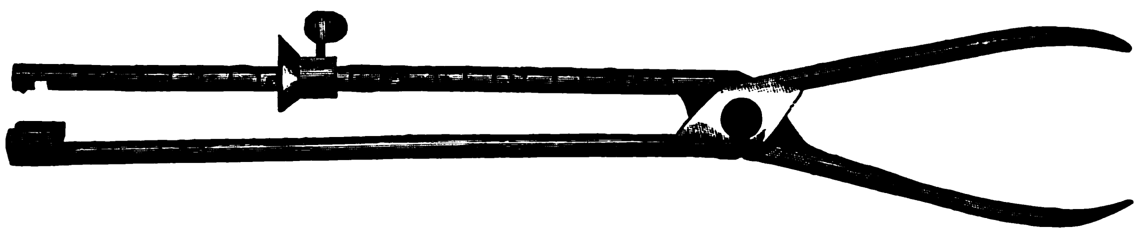
One of the most strikingly novel circulars it has been our privilege to see, was that distributed at the Providence Convention, by the Illinois Electric Material Co., of Chicago. Not content with anything of modern character, they have returned to the dark and misty ages for a fitting tribute to the merits of their insulation, which the ancients seem to have held in high esteem. This weird cryptogram, being translated, is as follows: "The Bishop insulated wires are the finest in the wire market, you bet." We are also assured that the antique touch never affects the insulation of their wire. It is further stated that this is the real philosopher's stone, and it is only necessary that purchasers of high grade wire should follow its instructions in order to learn the heretofore hidden secret of making gold.



Bishop Wire "Ad." Found at Pompeii.

A GLASS TUBE CUTTER.

The accompanying illustration represents a glass tube cutter manufactured by Hunt & Connell, Ltd., of Scranton, Pa., and designed for cutting gauge glasses to length. One arm has a scale in inches and fractions of an inch, a slide stop with set screw, and a rotary cutter at the end. This arm is inserted in the end of the glass tube to the required distance, against the slide stop or gauge, the outside of the glass tube resting in the circled end of the other arm. With a slight pressure of one hand on the handles, and a rotation of the glass with the other hand, the rotary cutter makes an even cut around the inside of the tube, and a very little pressure breaks it off. The device is made in two sizes, cutting up to five and seven inches, respectively.



A Novel Glass Tube Cutter.

PARTRICK & CARTER CO.

Mr. Thomas L. Townsend will start early in March on his Spring trip in the interests of the Partrick & Carter Co. He will cover a very large territory this time, and will have, in addition to the standard goods of this house, several novelties which they are making, especially for the house goods trade. The new "King" annunciator will certainly be a go.

ADDITIONAL STORAGE BATTERY CARS ORDERED BY THE DUBUQUE COMPANY.

The Dubuque Street Railway Company is so well pleased with the experimental storage battery car operated on the Edco system and which has been running in regular daily service since last August, that it has concluded to order from The Accumulator Company three additional cars of the same kind, work on which, we are advised, has already been started; delivery to be made in April. This will make nine Edco cars in all which the Dubuque Company will have in operation, the first six of which are about ready for delivery, and will be installed in March.

We are informed also that The Accumulator Company has arranged with the Eckington & Soldiers' Home Railway Company to rent them two Edco cars, which are about ready for delivery, and which are to be operated by the Eckington & Soldiers' Home Railway Company upon the G street branch of that road between the Treasury Department and the Pension Office, thence to the corner of New York avenue and 5th street, pending the delivery of the six new Edco cars recently contracted for which will not be ready for delivery till about May or June.

THE ENGINEERING EQUIPMENT CO.

The Engineering Equipment Co., organized early in February have located temporarily at 73 Cortlandt street, New York. After April 1st they will be in the new Jersey Central building, Liberty, West and Washington streets.

The following gentlemen and others are actively interested in this new and promising enterprise: F. A. Magee, M. E., engineer; F. L. Perine, general manager; A. L. Tinker, secretary and treasurer. The company are contractors for steam and electric equipment materials. They represent the Underwood Manufacturing Co., of Tolland, Conn., makers of cotton-leather belts, and other specialties in the belting line, and are sole agents for the patent indurated fibre pipe used in electrical subway work and for other purposes. The Engineering Equipment Co. are also manufacturers' representatives of Corliss and high speed engines, horizontal and vertical boilers, wooden and iron poles, line materials, wire and cables, underground conduits, cars and trucks, iron roofs, cranes, etc.

It is the purpose of this company to furnish equipment materials of the best class at figures which will be attractive to intending purchasers, especially to those who desire to place large orders in safe, reliable hands and under conditions that will insure the exercise of sound judgment by experienced engineers.

A VERDICT FOR THE GOULD & WATSON INSULATORS.

The Detroit *Tribune* of Feb. 21, makes the following note: "The Gould & Watson Co., an Eastern concern founded for the dissemination of electrical appliances, sold a large number of insulators to the Detroit Electrical Works some time ago for use on street railways which are being built by the local concern in various parts of the country, including Texas. It was claimed after trial that the insulators were not all that they were represented to be, the composition of which they were formed yielding to the influence of the sun, and various other things which have no legitimate connection with rapid transit, and the Detroit company declined to remit until matters were straightened out. A replevin suit followed, resulting in a verdict yesterday afternoon for the foreign concern for $501.12."

Mr. H. E. Chubbuck, of Springfield, Ohio, has been in Chicago, exploiting the malleable brackets and break-arms which bear his name.

THE THOS. MURRAY CO.

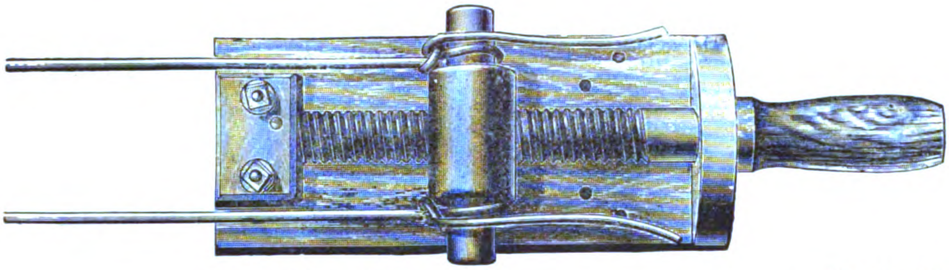
The Thomas Murray Company, of 95 Liberty street, New York, have received additional contracts for overhead construction for the Consolidated Street Railroad, of Columbus, O They expect to have the construction completed and cars running by June first. They have also commenced the work of the Grand View Beach Railroad, at Charlotte, N. Y. They expect to have this road completed and in running operation about May 15. This road is to be equipped with 40 h. p. Rae motors, Brill and Newburyport cars. It is expected to be one of the finest roads in the country.

BROWNLEE & CO.

Brownlee & Co., of Detroit, Mich., report the largest sales of poles for January and February that they have ever had. Their new steel poles are being very favorably received, and trade in wooden poles is growing rapidly. They have recently purchased 25 acres of ground at Detroit and will establish a large pole yard there. This will bring them about 200 miles nearer their customers and enable them to make very prompt deliveries.

A PATENT WIRE STRETCHER.

Wiremen and all parties engaged in running wires for electrical purposes cannot fail to appreciate this innovation in the line of construction tools, recently placed upon the market by L. E. Wilcox & Co., of Meriden, Conn. It is claimed that by its use one wireman can do the work ordinarily requiring two. The work is done with great neatness and facility and is not an eyesore.



Novel Wire Stretcher.

To use the stretcher it is only necessary to fasten it to the ceiling at one end of the line by means of screws, then, after fastening the wires at the other end of the span by means of cleats or porcelains, to pass the ends of the wires around the ends of the wooden nut and stretch the wires by turning the screw until the wire is perfectly taut and all kinks have disappeared. The cleats and rosettes are now placed, the stretcher taken down, and the next span proceeded with in like manner.

ACTIVITY OF THE DETROIT ELECTRICAL WORKS.

The Detroit Electrical Works, Detroit, Mich., through Mr. C. A. Benton, the indefatigable manager of their street railway department, have just closed a contract with the Eau Claire Street Railway, Light and Power Co., of Eau Claire, Wis., for two 30 h. p. equipments of the famous Rae system.

Mr. Joseph E. Lockwood, for many years with the Brush Electric Co., of Detroit, and well known as a bright and able electrician, has recently associated himself with the Detroit Electrical Works, who are to be heartily congratulated on adding another shining light in the electrical field to their staff. Mr. Lockwood will supervise the construction work.

GREAT SUCCESS OF THE INTERIOR CONDUIT SYSTEM.

The "interior conduit" system is meeting with phenomenal success upon the Pacific Coast. The Interior Conduit and Insulation Company are just in receipt of an order from their San Francisco representatives, Messrs. Thos. Day & Co., for 150,000 feet of tube, besides elbows, sleeves and all the other appliances which go to make the system complete in its every detail.

The system is to be used throughout the new Mills Building, of that city. The Mills Building, of San Francisco, designed by Messrs. Burnham & Root, architects, of Chicago, will be several stories higher than the Mills Building, of New York, and will be lighted throughout by electricity, there being about 7,000 incandescent lights.

The Interior Conduit Co. has now received its Gold Medal, awarded it lately by the Massachusetts Charitable Mechanics' Association, for the fine exhibit made in Boston of its devices and appliances, and for the merit of the system.

THE BRAZELLE AUTOMATIC HYDRAULIC ENGINE GOVERNOR.

The accompanying illustrations, Figs. 1 and 2, show the Brazelle automatic engine governor, designed to maintain uniform speed of engine with all changes in loads.

The governing is effected by a force pump, A, Fig. 2, pumping oil against a piston B, through an opening C; this opening may be increased or diminished, to change the speed of the engine, by turning the hand-wheel D. The piston rises and falls by the action of the pump, thus regulating the supply of steam to the cylinder. It is claimed that the governor will admit fully 90 per cent. of the boiler pressure to the cylinder when necessary, and that, by turning the hand wheel D, the speed of the engine can be regulated from 20 to 300 revolutions and over. For incandescent lighting it commends itself, as its perfect control of the engine insures extreme steadiness of the light, and thus adds to the life of the lamps.

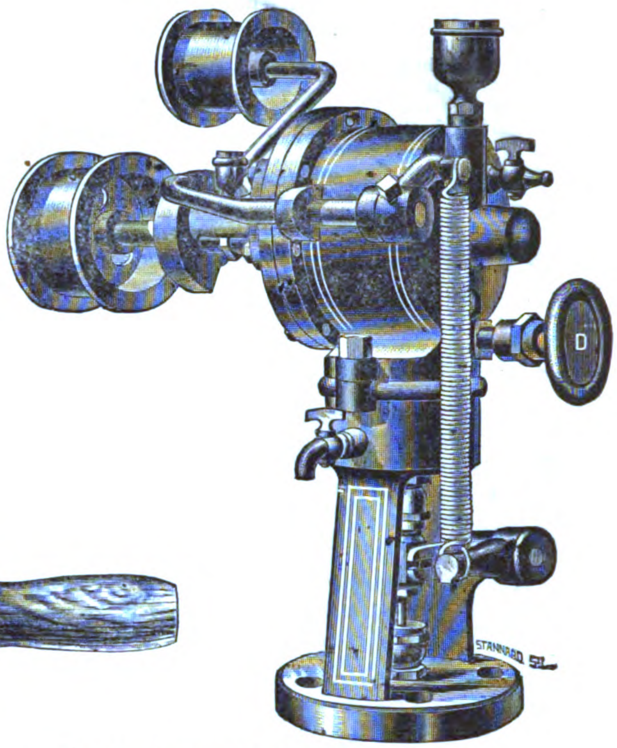


Fig. 1.—Brazelle Automatic Governor.

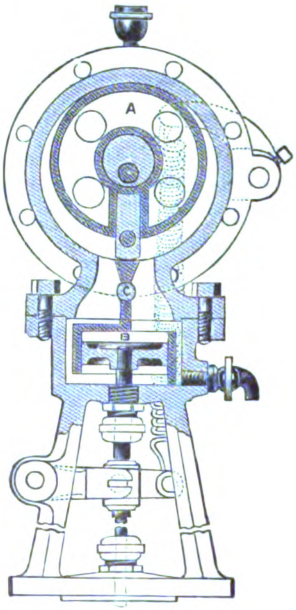


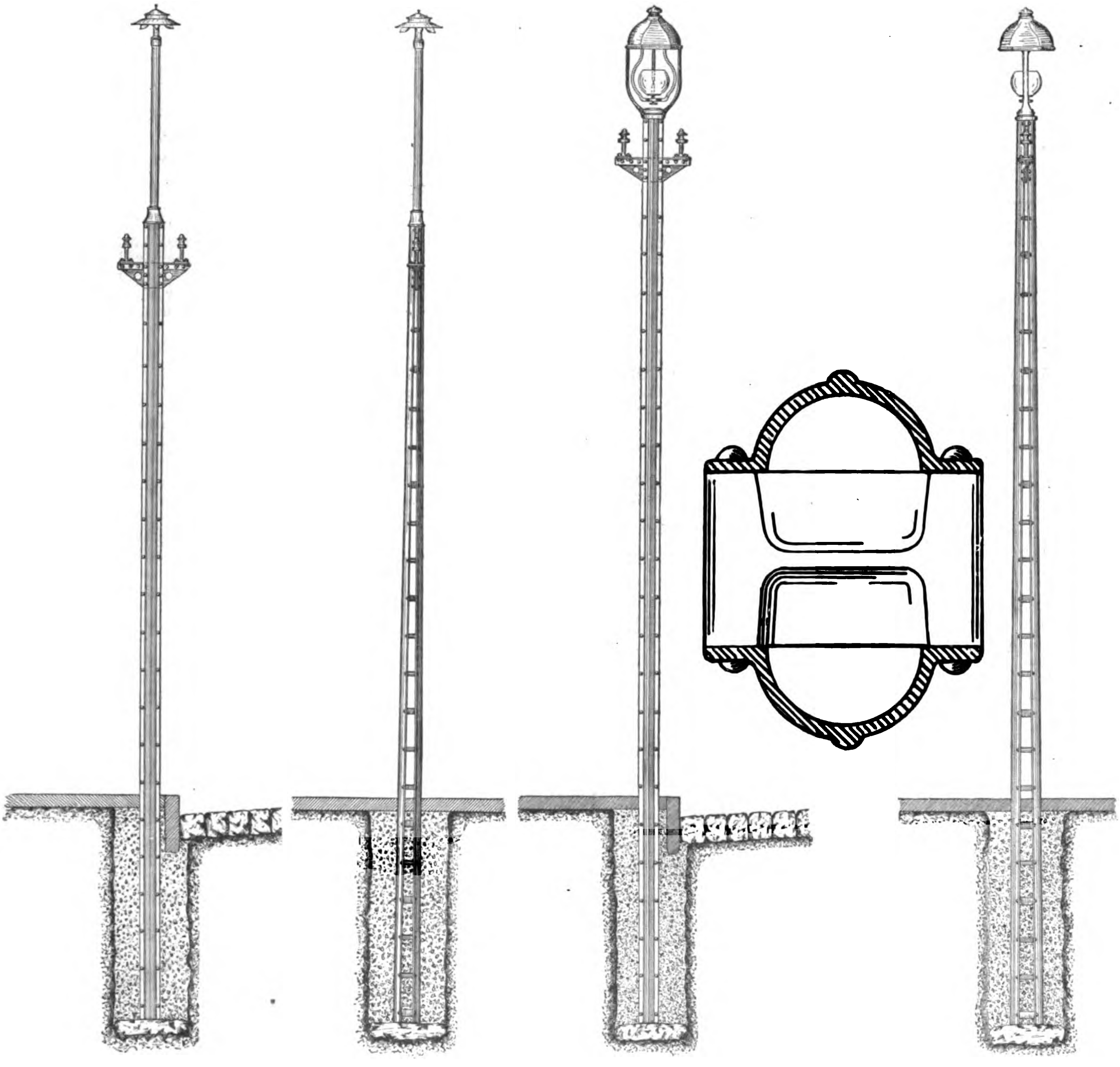
Fig. 2.—Detail of Brazelle Governor.

The Brazelle governor is manufactured by the Mid-Continent Manufacturing Co., of St. Louis.

MILLIKEN'S NEW ELECTRIC LIGHT POLES.

THE accompanying illustrations, Figs. 1 to 5, show a new form of pole for electric light work. This pole is manufactured by Milliken Bros., of 55 Liberty street, New York, and is an outgrowth of their street railway pole, recently illustrated in our columns, and which has met with such success.

These poles are constructed of two longitudinally flanged segments, connected by rivets and gas pipe separators, which vary in length, and thus give the pole a taper from the ground to the top. Occasionally cast iron separators are introduced to keep the segments in line. The section of the pole, Fig. 5, shows the form of the cast separator. They are claimed to be much lighter, and consequently cheaper, than any other form of pole made, as the minimum amount of material is used, representing the greatest strength. The greatest diameter of the pole is at the base, where the strain is the greatest.



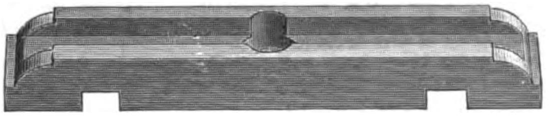
FIGS. 1, 2, 3, 4 AND 5.—MILLIKEN'S ELECTRIC LIGHT POLES.

The Standard incandescent light pole, Figs. 1 and 2, is arranged for the lights to be 18 feet above the street. The pole is set in the ground 5 feet. The brackets shown are arranged for two wires, although more can be used if necessary. The top of the pole is supplied with a cast iron reducer into which 1½ inch gas pipe screws. The top of the gas pipe is threaded to receive a hood which carries the lights. The hood is furnished by nearly all the electrical companies, and can be arranged with a reflector when necessary. When these poles are used in connection with subways, a hole is cored in the cast iron separators, and the wires then pass directly up through the centre of the pole. They can be protected by any of the usual forms of insulation and cut-outs, or switches can be inserted at convenient points. The arc light pole, Figs. 3 and 4, is similar in construction to the incandescent light pole, just described, except that the pole proper runs to the base of the light. They can be arranged at the top to fit any special make of lamp, and can also be arranged for carrying the incandescent or arc lights on arms of any length.

These poles have been extensively used in South American countries for ordinary forms of line work, such as telephone and electric light work. It has been found that, in these warmer countries, different kinds of insects attack wood, and in a very short time entirely destroy the fibres, causing the pole to break short off at the surface of the ground. Companies have also found great trouble in keeping lines in operation where they pass through thinly settled districts, as the natives cut down wooden poles and use them for fire wood. When furnished for line work, they are supplied with an iron cross-arm on which any number of pins are secured. These poles can be made of any length, and varying thickness, according to the strain put upon them. It is believed that such poles will find an extended use, especially after the experiences of the recent severe and troublesome winter.

A NEW "CROSSING" CLEAT.

The crossing cleat shown here has been brought out by the Electrical Supply Co., of Chicago, to answer the call for a device which shall not be cumbersome and yet permit the crossing of wires safely and conveniently. This cleat seems to fill the whole bill, and is unique in this respect at least, that it is no larger than the regular working cleat. It is necessarily more carefully made than the ordinary cleat, and will doubtless find favor with those requiring neat construction.



A "CROSSING CLEAT."

PERFECT SATISFACTION.

The Jerome Kidder M'fg. Co., of 820 Broadway, have received the following letter:—

401 N. High St., CHILLICOTHE, O., Feb. 3rd, 1891.

DR. JEROME KIDDER, 820 Broadway, N. Y.

Dear Sir:—Yours of the 30th received. Also Battery No. 5, packed with care and in good order. I find it all that you represent it to be. It gives perfect satisfaction. Enclosed find draft.

Very respectfully,

REV. F. SCHWAB.

THE BARRIETT ELEC. CO.

The Barriett Co. has changed its address from 120 Broadway to 10 Cedar street, where it has established its office and works. Mr. Barriett is busily engaged getting things into shape there, and is already turning out motors and other electrical work.

THE "AJAX" DRY BATTERY.

The Electrical Supply Co., of Chicago, reports a recent test of its "Ajax" dry battery with five of its competitors, in the following:

On Nov. 4th, 1890, the six batteries were selected from new stock and the voltage of each was taken. Four of them showed a greater E. M. F., and one was lower, while the Ajax stood at 1.32. They were then put on a circuit of 20 ohms resistance, and continued so until January 7th, 1891, at which time the Ajax stood .12 above the lowest and .02 above the next highest. On the last named date they were all disconnected and allowed to rest until February 13th, at which time the Ajax showed its great recuperative powers by standing at 1.18, only .14 below where it started one hundred days before, and after doing sixty-four days' continuous work. The next highest stood at .02 below the Ajax and the lowest at .20 below. After all this work the Ajax rang a bell as vigorously as ever, and it is claimed for it that it may stand on the shelf unused for months and lose none of its E. M. F.

PERKINS ELECTRIC LAMP CO.

The Philadelphia office of this company will be located at No. 806 Walnut street. The Boston agents are the well-known firm of Claflin & Kimball, 116 Bedford street, Boston.

THE WENSTROM CONSOLIDATED DYNAMO AND MOTOR COMPANY.

When this company came before the public last spring, it was their expectation to supply goods manufactured in their old works, and they expected to have their new factory completed by September 1, 1890. So rapidly, however, was the selling department of the business organized, that the facilities which the company had were soon over-taxed, and the result was that they were unable to fill their orders promptly. Every effort was then turned towards the rapid completion of the new factory at Calverton Heights, Baltimore, Md.

Many annoying delays arose, but Mr. Tunis, the president of the company, pushed ahead in spite of the numerous obstructions, and his efforts are at last crowned with success in the completion of the present factory.

The building is 100 feet front by 260 feet deep, two stories high in front, and four in the rear. No effort has been spared to make it the most substantial and complete electrical factory in the country. The building is situated at Calverton Heights, where there is one of the finest water powers in the State. The company purchased this entire property, consisting of nearly 100 acres, with the view of erecting a series of factories similar to the first, as the business demanded, and also to afford ample room for houses for their workmen and the laying out of the small town which must necessarily rise about such an important manufacturing centre.

Mr. H. F. Parshall, who is well known as an expert electrician, and more widely, perhaps, as the designer of some of the most successful electrical apparatus in the country, has had complete charge of the electric work connected with the Wenstrom Company. He has fitted up the factory with a large amount of high class tools, which will enable them to turn out fine apparatus with great rapidity.

A large number of Wenstrom dynamos had been manufactured and put in operation in this country by the Wenstrom Company before its re-organization, and it is interesting to note that all of these have been entirely satisfactory, although manufactured under the original designs without any of the most modern improvements in mechanical details which are commonly used in the most perfected machinery.

Since Mr. H. F. Parshall has been head of the Electrical Department of the Wenstrom Company, he has made many important changes in designs and general details, and has brought the Wenstrom apparatus up to the highest standard.

NEW ENGLAND TRADE NOTES.

THE JEWELL BELTING COMPANY, recognizing that the demand for electrical construction throughout the country during the coming year will be enormous, have now arranged their works so as to meet all the requirements of a rapidly increasing business in dynamo belts. They have never had so many large driving belts in process of construction at one time as now. Most of them are to transmit power in electric light and power stations. The collection comprises two belts 40 inches wide, one 36 in., one 35 in., four 32 in., one 30 in. three-ply thick, two 30 in., two 24 in., one 23 in., besides a large number ranging from 16 inches to 20 inches.

THE EASTERN SUPPLY AND CONSTRUCTION COMPANY, of Boston, have appointed Mr. H. F. Kellogg as manager of their light and power department. Mr. Kellogg has been associated with this company as salesman, and his early training with the Thomson-Houston Company adapts him well for this class of work. The business of the company is rapidly increasing in all its branches, and they are at present engaged in a number of electric railway enterprises.

THE ECONOMIC ELECTRIC MANUFACTURING COMPANY, of Boston, have appointed Mr. E. A. Clark as general agent for the sale of their lamp. Mr. Clark has been for some time connected with the Economic Company, having had charge of their mechanical department at Brockton, so that he brings with him a thorough practical knowledge of the manufacture of incandescent lamps. The Economic Company are now making about 700 lamps a day, and are adding to their facilities of manufacture all the time. Report has it that the Economic lamp is a good one, and is well worthy of a trial by all consumers of incandescent lamps.

THE ELECTRIC AND MACHINE COMPANY, of Boston, owing to the increase in their business and for the convenience of their customers, have transferred their offices from the fourth floor to the first floor, and have now a comfortable suite of offices, within reasonable distance of the sidewalk. Mr. J. C. Wilson, the proprietor of the company, is also now better able to give more of his time to consultation work, and his long experience in electrical business of every variety should make his advice valuable to all enquirers.

THE ELECTRIC GAS LIGHTING COMPANY have just issued another circular full of "most positive and convincing evidence" of the superiority of the Samson battery. It consists of extracts from letters of innumerable users, and a most interesting comparative report by Prof. Dolbear on the performance of two cells Leclanche and two cells Samson. If any one still doubts the Samson, let him at once procure this circular, read and be convinced.

WESTERN TRADE NOTES.

MR. FRANK R. MERRILL has completed arrangements to handle the storage batteries of the Consolidated Electric Storage Co., of New York, and the Loomis system of incandescent lighting, manufactured by the Eureka Electric Co., of New York. Mr. Merrill has opened handsome offices at 565 Rookery building, and will be pleased to see his many friends there

MR. W. R. MASON, the manager of the Electric Merchandise Co., of Chicago, has just returned from Pittsburgh, where he secured the agency for the Tramway Rail Co., manufacturers of steel rails, chairs, and auxiliary appliances for street railways. The Tramway Rail Co., by reason of their large means and unusual facilities, will immediately take rank with the foremost manufacturers of rails in the country. The Electric Merchandise Co. are increasing their business all the time, and in the acquisition to their staff of Mr. D. B. Dean, as general traveling representative, will extend their trade more and more.

THE
Electrical Engineer.

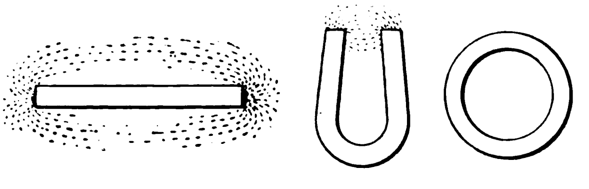
VOL. XI. MARCH 11, 1891. No. 149.

ON CHANGE OF FORM AFFECTING A MAGNETIC FIELD.[1]

BY

A. E. Dolbear

HITHERTO the study of a magnetic field has been the study of the so-called lines of force radiating from the poles of magnets, either electro or permanent, and so far as magnetism has been utilized in the arts, the changes in this external field have been brought about by the movements of an armature, having for its function to determine the direction and consequent density of the field. Such is the case in the instruments used in the telegraph, the telephone, dynamos and motors. Sometimes conducting wires are so mounted in the field that their movement gives rise to electric currents, which signifies that the energy producing the tension in the field is absorbed in some measure by the moving wires, and is transformed into an electric current. In each of these cases, the magnet producing the field is stationary, that is, changes in the magnetic field produced by it, are due to motions external to the magnet itself and may be that of an armature, of moving wire, or of its own bodily change of position—a kind which is comparable with what is called external motion, in thermo-dynamics, to distinguish from internal motions or such as take place when the body changes its form. So far as I am aware, no study has been made of the effects of changing the form of a magnetic body on its field, or of the reaction upon itself, of its magnetic condition due to a periodic change of form. Of course, it has been known for a long time that the form of the magnetic field depended upon the form of the magnet itself. For a straight bar magnet, this field is familiarly known by the arrangement of iron filings forming curved lines from each pole re-entering the opposite pole, as in Fig. 1. When the iron is bent into a U form or horse-shoe magnet, Fig. 2, the field is contracted to little more than the space between the poles. These forms of magnets have been *permanent* ones for the purpose for which the magnets were made.

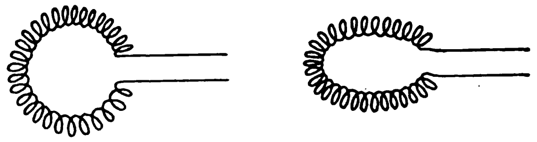


FIGS. 1, 2 AND 3.

In the case of an induction coil, whether of one form or another, the magnetic change produced by it, has been and is due to the *electric* change produced upon it by an electric circuit provided with intermittent or alternating currents.

Within a few years attention has been called to the nature of the external field, as being a part of what is now known as the magnetic circuit, which consist of these *rings* or closed circuits of lines of force, all originating in the iron part of the circuit, and for *conducting* which, iron is by far the best. The poles of the magnet are simply the parts of the iron where the lines enter and leave, and they may be in any place. Usually they are at the ends of the iron, but not necessarily so. Whenever iron is placed in the magnetic field, these lines crowd into it, as it is so much better conducting than the ether. When the iron is made into a ring, Fig. 3, and then magnetized, there is no external polarity and, consequently, no external field, provided that the iron has sufficient conducting cross section at every part.

The following experiments have been tried, to determine what effects, if any, are produced upon a magnetic field by changing the form of a magnet. It was thought, at first, that if a helix was coiled into a circle, Fig. 4, and a current was present in it, a change in its form to that shown in Fig. 5 would produce a corresponding change in the magnetic field external to the coil, especially noticeable if a flexible iron ring was enclosed in the helix so as to condense the magnetic field. This was put to the test in the following manner:—



FIGS. 4 AND 5.

(I.) A coil, similar to the one described above, but containing a solid ring of iron, about eight inches in diameter and an inch thick, had its coil put in circuit with a reflecting galvanometer of low resistance, and at such a distance from it that magnetic fields external to its circuit could not act upon it. Another coil, made about a flexible ring of iron wire, was put in circuit with a battery so as to magnetize the ring strongly. Then, with one ring parallel to the other, the flexible one was made suddenly to assume an elliptical form, Fig. 6. Each such change in form from one ellipse to another at right angles to it, gave a deflection of the needle to the right or left, and uniformly for a given phase of change. It was, also, observed that the direction of the deflection was reversed when the flexible ring was turned the other side up.

(II.) The same flexible ring, used in the same way, but without the current through it, gave substantially the same results. Of course the ring was permanently magnetized, and the change might have been inferred.

(III.) As the same kind of motion, due to change of form, is taking place when a ring is vibrating at its harmonic rate, producing what we call sound vibrations, it was thought probable that a magnetized ring, having a coil of wire about it, in connection with a telephone, would set up vibratory currents when it was struck; and this was found to be true, for when the coil containing the heavy iron core was put in circuit with a telephone in another room, the sound of the stroke and the pitch of the ring could plainly be heard. In the first case, the number of turns of wire was small, perhaps fifty or thereabouts. I, therefore, had two larger rings made, each about one foot in diameter and half an inch thick.

(IV.) One of these was wound with six or seven hundred turns of No. 32 wire. Before it was magnetized it was connected with the telephone and tested for its magnetic condition by striking. The ring could plainly be heard, which showed that it had some degree of magnetism.

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[1] Based on a paper read before The American Academy of Arts and Sciences.

(V.) Then, about two hundred turns of coarse wire was wound upon it and a strong current sent through it to magnetize it. After this magnetizing coil had been removed, the ring was again tested as in IV. The sound was very much louder. Indeed the telephone could be held a foot from the ear and be heard.

(VI.) With the ring in V still in circuit, the companion ring, without any wire upon it, was brought near it and struck. The sound was easily heard in the telephone circuit.

(VII.) This second ring was now magnetized in the same way as the first, when the magnetizing helix was removed, and the experiment VI repeated. The sound was *very* much louder.

(VIII.) The ring was now struck and moved away from the first ring by stages of an inch or two at a time. It was found possible to hear its pitch in the second circuit, when it was a yard or more away from it.

(IX.) As the pitch of the two rings was not quite the same, the higher one was loaded so as to bring them to unison. The sound was then louder and more persistent than before. This gave evidence that it was a case of sympathetic vibration, while the former ones were forced vibrations.

(X.) A common horse shoe permanent magnet, with legs about six inches long, had perhaps 50 ohms of No. 32 wire wound about the bend, and this was put in circuit with the telephone, as shown in Fig. 8, and struck like a tuning fork. The sound was remarkably loud. It was too strong to be held comfortably at the ear.

(XI.) A coil of wire was now put about the middle of a piece of gas-pipe, which was without permanent magnetism. The piece of pipe was about 4 feet long and $\frac{5}{8}$ of an inch in diameter. This, when in connection with the telephone, was struck two or three times a second, with a piece of brass rod, and while being thus struck, it was rotated from the magnetic meridian to a position at right angles to it. The difference in the loudness of the sound, between the position in the meridian and away from it, was very marked.

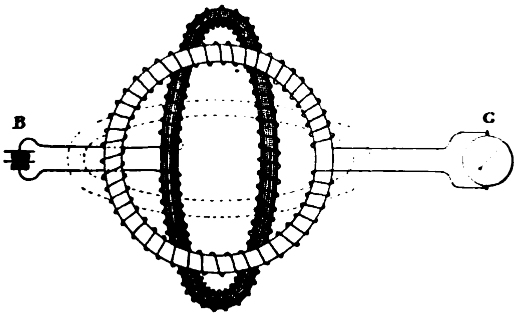
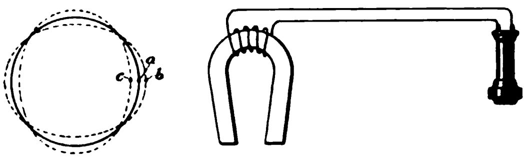


FIG. 6.

It is therefore shown to be possible to determine the points of the compass with a telephone, a coil, and an iron rod.

(XII.) A second flexible ring was now made, about a foot in diameter, consisting of a bundle of soft iron wire, the ends being roughly braided and twisted together, the thickness of this was rather less than half an inch. This was covered by a rubber tape wound spirally around it, the better to secure stability of form and isulation. Then 4.6 ohms of No. 21 wire was wound about it its entire length, making probably 1,000 turns. It was then magnetized by a current from 3 secondary cells having 6 volts, giving a magnetizing current of about 1,300 ampere turns, leaving it a ring magnet. The terminals were then connected with the terminals of a reflecting galvanometer with a resistance of .67 ohms. Very slight changes in the form of the ring, either by pulling or pushing, gave decided movements to the needle, while larger amplitude gave 30 to 40 degrees deflection.

(XIII.) It was noticed, also, that the direction of the current depended not only upon the direction of the motion changing the form, but also upon the direction of the motion with reference to the normal shape of the ring. Thus, if the ring be drawn into a horizontal ellipse, the current will move the galvanometer needle, say to the right. When it is brought back to the circular form, the circuit is reversed. If the motion be continued so as to produce a vertical ellipse, the current will be in the same direction as that produced at first by a motion exactly opposite in direction; so that for a complete cycle of vibratory changes, four currents are generated, two direct and two reverse. For instance, in Fig. 7, when a point *a* is moved to *b* the induced current may be direct, but it will also be direct if point *a* be moved to *c*, so that for the movement *a b c* there are currents that may be thus represented.



FIGS. 7 AND 8.

(XIV.) One of the iron rings, before mentioned, a heavy one about 8 inches in diameter and an inch and a half thick, having coarse wire wound upon it nearly covering the ring, was connected with the galvanometer as before, and the ring was struck by a brass rod. The needle instantly swung through a wide angle. Struck again, it moved as before but not through so wide an angle, and a half dozen blows knocked nearly all the magnetism out of the ring. This was then detached from the galvanometer and magnetized as before, when it again gave the same large deflection it gave at first. The same conditions were tried with other rings and in each case it was found that a vigorous stroke upon the ring magnet had the same destroying effect upon the magnetism, as it is known to have upon magnets having external fields.

The flexible ring was now put in circuit again, and vigorously jerked with the hands. A very few such movements served to destroy nearly all the magnetism present, requiring the re-magnetization of the ring.

As flexible iron rings such as I wanted were not easy to make, I procured some steel wire rope of the right size and the ends were welded for me through the courtesy of Prof. Elihu Thomson, of Lynn, by his electrical welding process. Such a ring, about a foot in diameter, allows a movement of five or six inches to one of its sides. This, when wound with four or five hundred turns of No. 22 wire may be magnetically saturated by sending a current through the wire, leaving the ring charged. The terminals may now be connected with a proper galvanometer, and changes in the form will discharge the ring.

These experiments prove:

1. That a change in the form of a magnet causes a corresponding change of stress in the field.
2. That periodic changes in form, due to elasticity of form such as are called sound vibrations, set up similar periodic changes or waves in the magnetic field.
3. That such sound vibrations of a magnet, act upon other magnets like sound vibrations and set them into corresponding vibratory movements, sympathetic or forced; sympathetic, when the receiving magnet has the same pitch as the transmitting magnet, and forced, when it has not the same pitch.
4. That such sound vibrations in the receiving magnet cause a corresponding change of form in its magnetic field, which manifests itself by electric currents in circuits surrounding it.

Sir William Thomson has frequently said that he could understand a mechanical idea when he could make a model of it, but could not otherwise. If one assumes that the ultimate atoms of iron are magnets, as is thought most probable now, or holds, by Ampère's hypothesis, that currents of electricity circulate about each one, making it a magnet,—in either case, each individual atom has its own magnetic field, which is, necessarily, always with it. It is really its reaction upon the ether. If such atoms be elastic, as there are the best of reasons for believing, then it follows that impact must set them into periodic vibratory motion, that is, periodic change of form at a rate depending upon their degree of density and elasticity. Such changes of form set up corresponding periodic waves in the ether, as changes in the magnetic field, and these are transmitted outwards, at a rate depending upon the properties of the ether to transmit such motions, and not upon the source of the disturbance.

Such vibratory motions among atoms and molecules we call heat, and such periodic waves in the ether, we call light, and thus Maxwell's idea of light being an electro-magnetic phenomenon is altogether in accordance with the experiments.

For waves of the lengths of light waves, it is essential that the vibrating body be small and highly elastic.

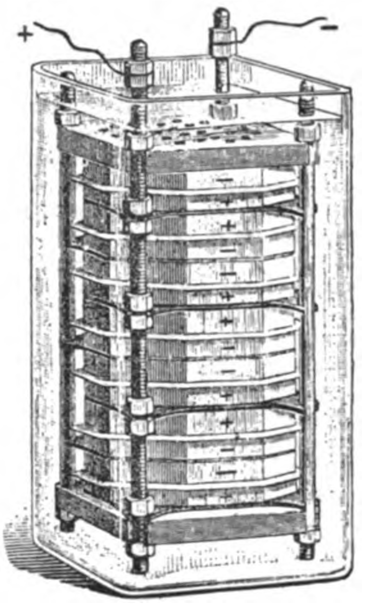
Maxwell's idea was that the opposite phases of ether waves could produce opposite electrical effects so that each half vibration represented either positive or negative conditions; and these implied, though I have not noticed the statement, that they must have originated with vibrating magnetic atoms or molecules. It has been difficult or impossible heretofore to imagine how ether waves could be set up by vibrations of the elements, though the idea that the atoms of matter are magnets is not new at all, and has a good degree of probability. If one is to picture to himself at all how this kind of a phenomenon can occur, he is bound to have in mind some form for an atom that shall, at the same time, be a consistent magnetic form. If atoms are magnets, it is well nigh inconceivable that they should be spheres, or cubes, or tetrahedra, or discs, or any of the ordinary geometric forms, for such would be very poor forms to exhibit magnetic properties. But a ring presents a very different case, as a ring magnet is the most perfect form possible. There is this to be said of such a form, however; it does not present what *we commonly call* a magnetic field; it is a closed circuit. Nevertheless, I would ask if it is probable that the ether, external to a magnet of that form, should be quite unaffected, quite neutral? I should suppose not, but, on the contrary, should look for some sort of stress there, though it might be of a somewhat different nature, and have somewhat different properties from an ordinary magnetic field. But if such were the case, it follows that any magnetic change in the ring magnet itself, would be followed by a corresponding change in the external field, and vibrating motions would necessarily set up waves in that field. Such waves would have a magnetic origin, but the waves themselves would not necessarily give rise to electro-magnetic effects directly. Indirectly they would, for if they could make another similar magnet vibrate sympathetically, these vibrations would react upon its magnetic properties.

Such a ring form as I have shown, suggests at once the Vortex Ring theory of atoms, the properties of which I have so often spoken upon in this place. Perhaps the experiments should have a different interpretation from that suggested here, but whatever their interpretation may be, they are believed to be entirely new, and therefore of interest, if not important.

Mr. Charles Francis Adams.—It is intimated by the New York *Journal of Finance*, that, upon his return from Cuba, at the end of March, Mr. Charles Francis Adams will become identified with the Westinghouse Company.

THE ATLAS ACCUMULATOR.

At a recent meeting of the Société Internationale des Electriciens, M. R. V. Picou read a paper on the "Atlas" accumulator, the outcome of the joint labors of Mr. Carl Hering and MM. Abdank-Abakanowicz, d'Arsonval and a Picou. Each element, as shown in the engraving, consists of pile of positive and negative plates separated by thin sheets of perforated indiarubber, thin sheets of lead being "sandwiched" in at intervals. The positives are of peroxide of lead, and the negatives of spongy lead, both being pierced with numerous holes. The pile of plates is kept in position, and electric connection is effected, by means of nuts and bolts of an alloy of lead, as shown, which are arranged to permit of expansion in every direction.



The Atlas Storage Battery.

The following are some of the data given by M. Picou:

Porosity of Plates . . = 50 per cent.
Density of Plates . . = 4
Capacity per lb. of plate = 9. amp. hours.
Discharging curreut . = .7 to .9 amp. per lb. of plate.
Dimensions of a 150 ampere hour cell . . = 6¼ × 7¼ × 13 inches.

In the course of his remarks M. Picou stated that he had found out experimentally that accumulators ought preferably to be charged at a constant E. M. F. of about 2.3 volts per cell. M. Hospitalier confirmed this statement.

ELECTRIC PREPARATION OF HYDROSULPHITE OF SODA.

Hydrosulphite of soda is a salt not much used in commerce; it is almost exclusively used in dyeing, either to lighten indigo tanks or to bleach silk or wool. It is almost always prepared by the Schützenberger process, which consists in making zinc react upon a solution of bisulphite of soda. These manipulations are long, and the cost is high. An electric process has been described by M. Villon, both more rapid and cheaper than the present one. The bisulphite of soda is reduced by the electrolytic hydrogen; 88 kilogrammes of bisulphite of soda, require to be completely transformed, three kilogrammes of hydrogen instead of two, the theoretic figure. The operation is carried out in a pine trough with porous earthenware divisions; one compartment contains the negative carbon electrodes in 300 litres of bisulphite of soda at 35 deg. Beaumé; the positive electrodes dip into a solution of sulphuric acid diluted with 10 times its volume of water. The trough is hermetically sealed, and the current is passed until four kilogrammes of hydrogen is formed. This operation takes 350 horse power hours. The hydrosulphite is then ready for use. The net cost of these 300 litres is 6f.

NOTES ON ALTERNATING CURRENTS OF VERY HIGH FREQUENCY.

BY

Elihu Thomson

THE interesting account of the novel experiments given by Mr. Nikola Tesla in the *Electrical World* of Feb. 21, 1891, and relating to the phenomena of alternating currents of very high frequency, lead me to make a statement of some of my own obervations while working in similar directions. The highest number of alternations which I have had at my disposal up to the present have been 8,000 to the second, a rate somewhat below that which Mr. Tesla has obtained, but which, nevertheless, shows properties and brings about actions and results similar to those which he described. The physiological actions of these rapidly alternating currents have been very ably investigated by Dr. Edward Tatum, some of the results of whose work I have presented in a separate communication.

Mr. Tesla's experiences in relation to the static effects of these currents of high frequency are similar to those noted by myself, particularly the small surface of the condenser which is able to transfer, or permit to be transferred, a considerable amount of energy through a dielectric, owing to the exceedingly high rate at which the changes of direction of charge are made.

The following experiment which was tried by me some months ago, is interesting in this connection. An incandescent lamp bulb was constructed, in which only a single platinum leading-in wire was used, on the end of which, inside the bulb, was mounted a single slip of carbon, two or three inches in length, it being one leg of a broken incandescent lamp filament. Two-thirds of the lamp bulb was now immersed in an outer vessel of water, leaving the single wire above the water for attachment to the source of alternating currents at one terminal, and the other terminal was connected with the outside water, which was rendered slightly conducting by salt dissolved therein. The water surrounding the lamp bulb formed, of course, an outer condenser coating, while the vacuous space and straight slip of carbon were the means for the conveyance of a charge to and from the inside surface of the bulb, which was, of course, exhausted to the ordinary vacuous condition, as found in an incandescent lamp. When an alternating potential of about 1,000 volts, and with a rate of alternations up to 5,000 per second, was applied to the carbon strip, the filament was brought to bright incandescence simply by the bombarding action of the residual gas, as in the Crookes tubes, while, of course, no complete circuit existed, the condenser action of the lamp bulb allowing sufficient current to flow. At the same time the glass of the lamp bulb not immersed in the water, became rapidly heated, indicating that that portion which was immersed in the water would have become equally heated had it not been subjected to the cooling action of the water itself.

The retention of the arc, as with direct currents, and the high note evolved by it, have been noted from the beginning of my experiments with these high period currents. Mr. Tesla expresses surprise that he was enabled to hear the note from an arc in which the alternations of current were more than 10,000 per second. Mr.Tesla will pardon me for calling his attention to the the fact that he is taking as the limit of audition in this case sounds from 5,000 to 10,000 complete waves per second, which is far below the limit at which sounds become inaudible to ordinary ears, cases existing in which a pitch corresponding to over 30,000 per second has been heard, according to some authorities.

The cause of the persistence of the arc with very high period alternations as stated by Mr. Tesla is undoubtedly the correct one, *i. e.*, that the gas stream has no time to cool between the alternations, and its variations of temperature must therefore be quite slight. The conductivity of the vapor or gas stream constituting the arc therefore remains nearly constant when the rapidity of alternations is sufficiently great.

The characteristics, stated by Mr. Tesla, as requisite to be possessed by machines suitable for obtaining constant current for the working of arc lights, are of course connected with the fact that in such machines the characteristic curve indicates a drop or fall in the electromotive force developed on a slight excess of current above the normal and, on a decrease of current, a raising of the electromotive force to a point above the normal.

It is not, however, in accordance with my experience, that the undulation of the current is almost essential to the success of an arc light system, nor do I think that properly constructed clutch lamps depend for their success any more than do finely constructed clockwork lamps, on the presence of a rapidly varying current due to a small number of armature coils and correspondingly small number of segments in the commutator. In fact, I have run with perfect success clutch lamps in circuit with coils of such large self-induction that any but very slight fluctuations were wiped out, and without introducing any particular difference in the behavior of the lamps. It probably is true, however, that slight gentle fluctuations occurring at very moderate intervals may be of benefit in the working of clutch lamps by keeping, as it were, the clutch mechanism in a state of vibration or tendency to open or close, but it can scarcely be doubted that if this benefit exists for such lamps a similar benefit would exist on the operation of clockwork lamps, as a similar fluctuation would give rise to a continual tendency in such lamps to keep the detent or escapement free enough for delicately letting-go teeth for the feed; but the fact that large numbers of lamps are in use in which the feeding of the carbon, either by clutch or by clockwork, is under the control of a derived circuit magnet only, and that such lamps operate with the greatest satisfaction, shows that the undulations mentioned by Mr. Tesla are not necessarily a factor to be considered. In such cases the self-induction of the arc branch is negligible as compared with that of the derived circuit magnet controlling mechanism, and the fluctuations therefore would pass through the arc without affecting the said magnet to a perceptible degree, particularly as the potential around the normal arc with slightly different current strengths flowing is nearly constant.

I may add that the experiments of Mr. Tesla in relation to the action of the condenser and the elevation of potential brought about by it are decidedly interesting and point to the possibility of obtaining a pure resonance effect. This would require, however, that the periodicity of the alternations be preserved very rigidly during the experiments, and involves the production of an unvarying or perfectly constant speed in driving the generating machine, a condition not easily obtained in practice.

In making the above notes on the highly interesting and valuable account given by Mr. Tesla, I desire to state that in whatever way my notes may appear as criticism of Mr. Tesla's views, they are not made in any unfriendly spirit, but with the desire of reaching the exact facts which it is the object of scientific investigation and discussion to ascertain.

SITES FOR CENTRAL STATIONS.

ACCORDING to the *Elektrotechnische Zeitschrift*, the simplest method of determining the best site for a central station will be to find the centre of gravity of the system, taking the values of various points in the area as proportionate to the density of current to be supplied at these points, in which case the total weight of copper in the feeders will be at the minimum. This calculation will, however, have to be modified when the considerations of cost of site and rent and, it may be, cost of cartage of fuel and so forth, are taken into account.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XVI.

(*Copyright The Electrical Engineer.*)

BY

Herbert Laws Webb

CONNECTIONS OF PERMANENT SET OF TESTING INSTRUMENTS.

In Fig. 36 is shown a diagram of a complete lay-out of testing instruments for use in the testing room of a wire factory, electric-light, telephone or telegraph central station. The instruments required have already been fully described, and in describing the lay-out and connections it is only necessary to briefly enumerate them once more, as follows :

Astatic reflecting galvanometer with box of shunts, lamp stand and scale.

Galvanometer reverser.

Short circuit key.

Discharge key.

Battery reversing key.

Wheatstone bridge (for permanent use, preferably of the dial pattern).

High resistance box, 100,000 ohms or one megohm.

Adjustable condenser.

100 cell testing battery.

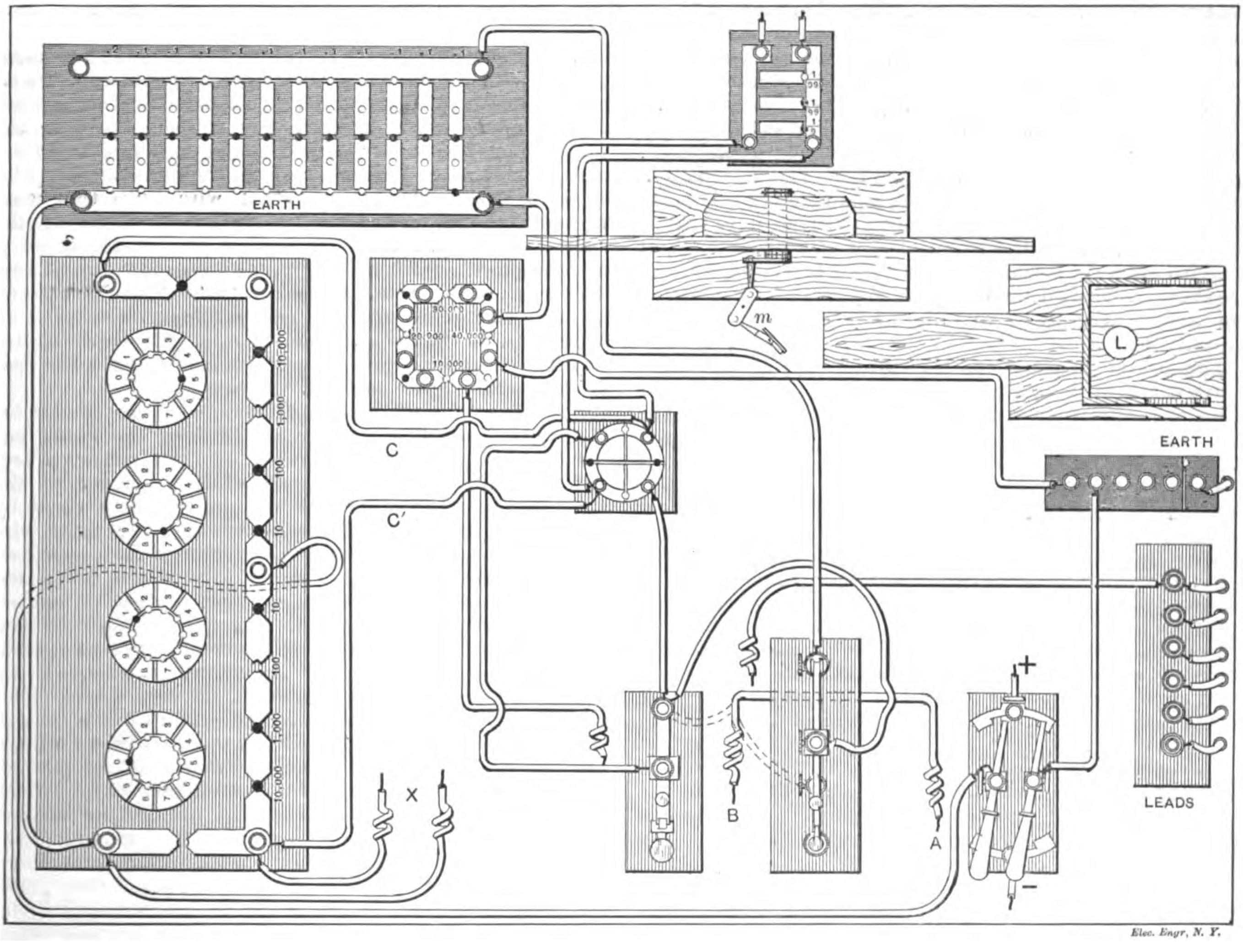
Set of insulated double binding posts for attaching leads running to factory or cable terminals.

Set of single binding posts on brass plate for earth connections.

In the diagram all these instruments are shown, with the exception of the galvanometer and battery; their positions, however, are sufficiently well indicated by the leads from the shunt and battery reversing key. The omission of the galvanometer and battery allows of greater clearness and compactness in the diagram. The diagram shows the most convenient method of placing and connecting the instruments on the table; the galvanometer would be set upon a shelf removed a short distance from the table and the battery on another shelf, either at the side of the manipulator behind the table, or underneath.

Starting from the right hand lower corner of the table, we find the set of insulated double binding posts on which the leads running to the cables are terminated. Immediately above this is placed the brass plate with a number of single binding posts; this plate serves for connecting the instruments together or connecting them to earth, a stout wire being run from the end post to a good earth. The improved form of plate is shown with the end post divided from the rest of the plate, so that the ground can be taken off by removing a plug. This arrangement is useful when testing a looped wire for copper resistance, as the presence of a ground will often prevent a balance being obtained.

Above the earth plate is placed the lamp stand, from which projects a wooden channel directing the light to the mirror at the back of the scale, by which it is reflected to



Elec. Engr, N. Y.

FIG. 36.—DIAGRAM OF COMPLETE LAY-OUT OF TESTING INSTRUMENTS.

the galvanometer. The scale is of the ground-glass pattern previously described. Next to the set of insulated binding posts is the battery reversing key, of the Rymer-Jones pattern. One pole of the battery is connected to each of the crescent-shaped contact pieces at either end of the key; the right hand lever is connected to earth by a wire run to the earth plate. Near the left hand lever two wires are terminated, being attached to the table and spiralled so that either can readily be connected to the binding post on the left hand lever. One of these wires goes directly to the centre binding post of the bridge; the other is terminated between the short circuit and discharge key, and spiralled so that it can be connected to either key—to the short circuit in taking the galvanometer constant, or in testing for insulation; and to the second for capacity tests. So much for the battery connections.

Next to the battery key is placed the discharge key, and next to this the short circuit key. The short circuit key is permanently connected to the galvanometer reverser by two wires, and a short wire is run from one post of the short circuit key to the upper contact of the discharge key. At the back of the discharge key is terminated a wire from the condenser, which can be connected to the lever of the key for taking the discharge of the standard condenser. In the same manner a wire from the high resistance is terminated near the short circuit key, available for being connected to the binding post of the key opposite to that to which the wire from the battery key is attached. A short wire led from the insulated binding posts to a point between the short circuit and the discharge key serves for connecting any of the leads to either key for insulation and capacity tests.

The bridge is placed at the extreme left of the table; above it and at the rear of the table is the multiple-series adjustable condenser, and in the angle between the two the high resistance box used for taking the galvanometer constant.

We have already seen that one wire runs direct from the battery key to the centre binding post of the bridge, another wire from the discharge key to the condenser, and still another from the short circuit key to the high resistance; the other connections of these instruments are as follows: From the extremities of the bridge arms two wires are led to the galvanometer reverser, and spiralled so as to be readily attached to opposite segments of the reverser. It would be the same thing to take these wires to the short circuit key; but as this would overcrowd the wires in that neighborhood, it is more convenient to take them to the reverser.

To connect the unknown resistance to the bridge, two wires are led from the binding posts on the brass blocks at the left of the bridge; the infinity plug being out, one of these posts constitutes the extremity of one of the proportional arms, the other the extremity of the adjustable resistance coils. The two wires are preferably taken to the extreme right hand corner of the table and terminated and spiralled there, ready to be connected to a pair of the leads attached to the insulated binding posts. For greater clearness they are shown in the diagram just to the right of the bridge at x, as if for connection to a coil whose resistance is to be measured. The remaining connection of the bridge is from the end of the adjustable coils to earth or to the second pole of the battery; the condenser and high resistance also require to be connected in the same manner; and to simplify the wiring, a wire is run from one of the binding posts of the high resistance to the earth plate. The extremity of the bridge coils is connected to the "earth" block of the condenser, and this, in turn, is connected to the high resistance by another short piece of wire. In this manner the return circuit of the bridge, condenser, and high resistance, is effected with the greatest economy of wiring and connections.

The usefulness of the earth plate here shows to advantage: one lever of the battery key being permanently connected to it, the connections to one side of the other instruments can also be made permanent, and the plate serves both as a junction for the bridge, condenser, high-resistance and battery wires, and as a handy connection to earth whenever such a connection is required.

The galvanometer reverser is permanently connected to the shunt, and the shunt to the galvanometer. The position of the shunt is a trifle inconvenient, but it is best placed as near as possible to the galvanometer, or error may be introduced by the resistance of the leads between the shunt and the galvanometer. In any case, very thick leads should be used for this purpose.

The lay out of instruments and connections described above will be found very convenient for arranging a set of instruments for permanent use in one place. A table four feet by three accommodates the entire set, as shown in the diagram, a clear space being left between the short circuit key and the bridge, for placing the note book or test-blanks.

The diagram shows the instruments connected for measuring conductor resistance; as will readily be seen, the alterations to be made, in order to connect the instruments for any of the other tests, are very simple. To take the galvanometer constant the bridge wires are removed from the galvanometer reverser, and the bridge battery wire from the battery key. The short wire A B is then connected to the battery key and to the rear terminal of the short circuit key, the wire from the high resistance being attached to the front binding post of the short circuit key. The connections for taking the constant are then complete; the only change required to connect for insulation is to substitute, on the front binding post of the short circuit key, the short wire running to the leads for the wire connected to the high resistance.

To connect for taking the discharge of the condenser, the B end of the wire A B is removed from the short circuit key to the underneath contact of the discharge key, and the condenser wire is connected to the lever of the key. The short circuit key is held permanently open by the catch, thus insulating the contact, and the short wire which joins the two keys serves to connect the upper contact of the discharge key with one wire of the galvanometer. The other side of the galvanometer must, of course, be connected to the earth plate, and this is done by running a temporary wire from one segment of the galvanometer reverser to the high resistance, which, as previously shown, is permanently connected to the earth plate. This completes the connections for capacity, and to take the discharge of the cable merely requires the connection of the piece of wire joining the lead to the rear binding post of the discharge key, in place of the condenser wire. With the instruments and connections laid out in the manner shown and described, the changes from one test to another can be made very quickly and without any confusion. Most of the wires are fastened to the table, but some, such as the wire from the discharge key to the condenser, and those from the bridge to the condenser, battery and leads, can be carried underneath the table, or under the projecting ledges.

NATURAL GAS DUTIABLE.

A Washington despatch says: "The Assistant Secretary of the Treasury has approved the action of the Collector of Customs at this port, in exacting duty on the natural gas imported from Canada." The gas people are stirred up and claim the decision of the Department is incongruous, in that electricity for lighting purposes is permitted to be imported across the Rio Grande from Mexico without the payment of duty. A very nice question is involved, and there will either be a change in the Department's action or an electric plant will be established in Canada near Fort Erie, where natural gas will be turned into electricity and brought across the river free of duty. It is reported here that one of the big electrical companies is making arrangements to establish such a plant near Victoria.

BOTTOME'S ASYMMETRICAL ELECTRICAL RESISTANCE.

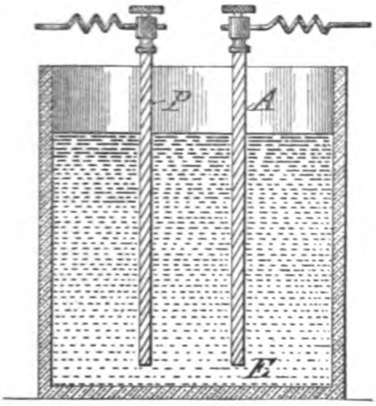
The accompanying illustration represents an "asymmetrical" conductor recently devised by Mr. Turner D. Bottome, of Hoosick, N. Y., for the purpose of directing alternating currents into currents of a continuous nature, suitable for energizing the field magnets of alternating current dynamos, and for electrolytic operations, etc.

As shown in Fig. 1, A is a conducting plate composed of aluminum. P is a conducting-electrode composed of platinum, carbon, or other inoxidizable element.

The fluid conductor is not intended to perform the office of an excitant, but merely that of a medium, and may be liquid, jelly, or semi-solid.

When the electrode A is electrically connected to the positive pole of an electric generator supplying a continuous current, and the electrode P attached to the negative pole, upon passing a current for a very short period of time, no unusual resistance will be offered by the device to the passage of the current; but upon reversing the direction of the current and passing it as before for a very short period of time, it is found that only a small portion of the original current passes, owing to the high resistance the device offers to the current in that direction.

The action taking place during this operation is supposed to be due largely to the peculiar nature of metallic aluminum under electrolytic action, and to the possible formation of a basic aluminum oxide of insulating properties upon the aluminum plates when the current passes in one direction, and the decomposition of this oxide into a soluble sulphate when the current is passed in the other direction.



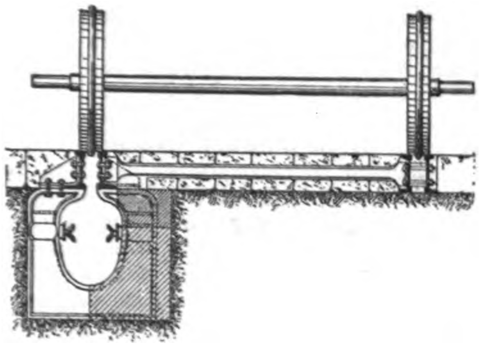
Bottome's Asymmetrical Resistance.

Being thus practically impervious to currents of one sign and permitting those of the opposite sign to pass, the arrangement, it is claimed, can be employed to sift out the varying impulses of the alternating current, allowing only those of one sign to pass, so that continuous currents of one direction can be obtained from an alternating current circuit.

THE BUDA-PEST ELECTRIC RAILWAY CONDUIT.

The continued success of the electric railway at Buda-Pest, in Hungary, equipped with an underground conductor system, by Messrs. Siemens & Halske, is attracting considerable attention to this system, both here and abroad. The track in that city is formed of one Haarmann rail and one slot rail. Under the latter is the concrete conduit, 11.2 ins. wide and 13.2 ins. high. Iron yokes are placed under this rail every 3.9 ft. The conductors consist of two small angle irons, one on each wall of the conduit, and at such a height that they are out of the way of water and dirt. The slot is 1.3 ins. wide and acts as a guide to the wheels on one side of the car as well as an entrance for the trolley rods. The lines include nearly 5.15 miles of both single and double track, and have been operated more than a year. The rolling stock consists of 50 motor and 8 trailing cars, which differ in few respects from those built in this country.

The construction here adopted will recall to our readers strongly the conduit system long since advocated by Mr. Stephen D. Field in this country. He designed such a system, with a conduit, the top of which formed the rail for the car to travel on, and worked out full details, such as are illustrated in the accompanying engraving.

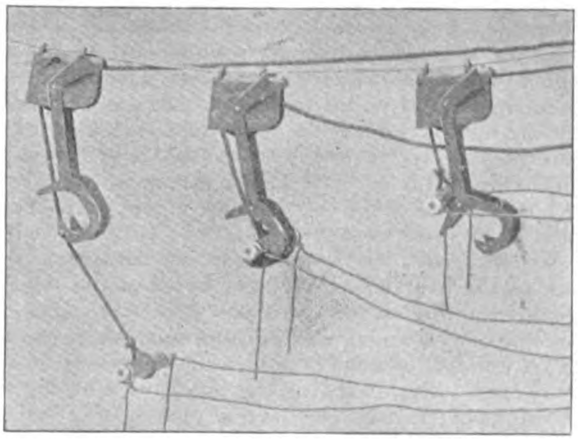


The Buda-Pest Electric Railway Conduit.

AN AUTOMATIC ARC LAMP REST.

The accompanying illustration represents a device invented by Messrs. Danals and Perry, of Zanesville, O., designed to allow an arc lamp to rest, when in position, so that there is no strain upon the rope, which is then only brought in use when the lamp is being raised or lowered. The engraving shows the lamp rest in three different positions, illustrating its simple construction and action.

The view at the left shows the lamp when being raised into position; that in the centre shows it hanging in the rest, with the lifting rope slack; while at the right is seen the lamp, lifted above the controlling fingers, preliminary to lowering; when the lamp is now lowered, the fingers push the hook back entirely clear of the lamp arm, so that the lamp is free to drop.



Danals and Perry's Arc Lamp Rest.

The rest can be attached to any pulley by simply taking out the rivet, and replacing it by a $\frac{5}{16}$ inch bolt extending through both pulley and rest. More than a hundred of these lamp rests are in use in Zanesville, where they are giving excellent satisfaction.

PHYSIOLOGICAL EFFECTS OF ALTERNATING CURRENTS OF HIGH FREQUENCY.

BY

Elihu Thomson

In connection with an experimental investigation of the properties of alternating currents of high frequency, and the phenomena which they present, it had occurred to me that it would be desirable to obtain data concerning the physiological effects of these currents as compared with the effects of currents of ordinary frequency. I had constructed a machine on the type of my new alternating dynamo, accounts of which were published some time last year.[1] In this machine an iron mass only is revolved, the central portion of which carries projections which pass near to the coils in which the currents are induced, which may be termed the armature coils, carried on the inner face of a laminated structure, and in turn supported by the outer framework of the machine. The machine with 100 armature coils and a speed of 5,000 revolutions per minute gives a little over 8,000 alternations per second.

The publication of brief notices of some of the results obtained in the operation of this machine led Dr. Edward Tatum, of Yonkers, N. Y., to correspond with me with the view of finding out whether I had intended to conduct any physiological experiments with the currents, and indicating his desire to experiment in this direction if the machinery for obtaining the currents could be placed at his disposal for a short time. Accordingly the machine was sent to Dr. Tatum some time last fall and was used by him in making a series of experiments, the results of which can not fail to be of the highest interest to electricians and physiologists. Very unfortunately Dr. Tatum has been an invalid since January last and has therefore been prevented from writing up the results which he obtained, some of which were transmitted to me in a letter dated December 29th, 1890, before he was taken sick. I will premise by saying that Dr. Tatum had intended to continue his experiments further before publishing any results of the trials. I quote from Dr. Tatum's letter as follows:

"The most definite and perhaps the most striking, as well as physiologically instructive, result has been in regard to the fatal efficiency of such rapidly alternating currents. When the circuit is formed through the head and body (of dogs) death occurs in the same manner as with other sources of current (which are made strong enough to kill by a closure lasting not more than two or three seconds), that is, by primary arrest and paralysis of the heart. But taking the fatal efficiencies of different sorts of currents as inversely proportional to the current strengths required to kill under otherwise similar conditions, a rate of 4,500 per second is not only far less efficient than rates of a few hundred, but it is distinctly less efficient than a continuous battery current. Indeed, in four of the five dogs that I have killed at the high rate a stronger nominal current was survived than I have ever before used (with a single irrelevant exception) to kill a dog. A nominal current of 1.35 ampere was entirely recovered from; the animal on the following morning showing no signs of physical or mental disturbance. This is four times the strongest fatal current at 300 alternations that I have used on normal dogs; six times the strongest current survived, and thirteen times the weakest fatal current. It is thirteen times the strongest fatal current used at 120 alternations; 20 times the strongest current survived, and eighteen times the weakest fatal current. It is remarkable that rates of 300 and of 120 alternations per second are fatally efficient at very nearly the inverse ratio of the numbers; but still more remarkable that the very highest rates should also present a strikingly near approach to a similar ratio. It must be noted, however, that no such ratio can hold throughout the whole range, for 36 alternations per second (from the same machine as furnished 120 and the 300 rates) are again distinctly less efficient than 120, something like two-thirds as efficient."

Dr. Tatum goes on to point out that a potential of 450 volts was survived at the high rate of alternations and the fatal current reached only at 495 volts, while 45 volts at 120 alternations similarly applied to the dog suffices to pass a fatal current.

Dr. Tatum also determined the ratio of pressure or potential to current in the dog just after the cessation of respiration, using in rotation, twice repeated, first, a continuous pressure or potential, secondly, an alternating one at a rate of 120, and, thirdly, an alternating potential at a rate of 4,500 per second at about 100 volts, and states:

"This ratio was so uniform (the extremes observed differing by less than 3 per cent.) as to dispose of any suspicion that the high period currents distributed themselves essentially different from others in the animal's body."

I will continue to quote from the Doctor's letter, as the results he obtained could not be so well expressed by myself as he has done in relating them:

"In regard to the physiological, as distinguished from the fatal, characteristics of the high period machine, I am only able to state the results in terms of pressure, instead of terms of current, as I should prefer. The limits of voluntary toleration for alternating pressures (applied with sponge electrodes) seems to depend very little on the frequency of alternation. For all the frequencies I have mentioned the limit has been found between 10 and 15 volts for applications about the face and head, and between 40 and 50 volts between the hands—without any decided preference in either case for one rate more than another.

"The cause of the pain which limits voluntary toleration seems to be in all cases chiefly in the muscular contraction produced. At 4,500 this muscular contraction is usually free from the thrill experienced even at 300; resembling, on the temples, nothing I can think of so much as firm pressure with the knuckles.

"The cutaneous nerves are distinctly less painfully affected at the high rate.

"The visual mechanism can not be excited at the high rate even by a pressure of 15 volts, so as to cause a sensation of flashes of light, although two or three volts similarly applied at 120 alternations causes such flashes very energetically.

"The sensation of dizziness caused by a few (four or five) volts applied behind the ears at a low rate of alternation of current can not be produced at the high rate.

"Sensations of taste are also absent.

"Directly applied to the exposed motor nerves and muscles of dogs and frogs, pressures at high frequencies seem less efficient as stimuli than at lower frequencies, in something like the same ratio as their killing power.

"The establishment of anything like an exact ratio I have not accomplished, owing partly to the very low pressures, which acted as very energetic stimuli when applied directly to fresh nerves. Thus a nominal potential difference of 1-20th of a volt in a length of nerve of 8 mm. of a frog's sciatic nerve still causes vigorous reaction. As the portions lose their vitality, however, stronger and stronger stimuli become necessary to elicit a response, and it is during this period of failing vitality that something like the above proportion is indicated between the respective pressures required to just produce a visible reaction."

Dr. Tatum's letter also contains references to the work which he had planned to carry out in the near future concerning the relations of alternating currents of high period to vital structures, which work he has been, I regret to say, prevented from pursuing by sickness, from which he has not yet recovered.

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[1] See The Electrical Engineer, July 30, 1890.

He also makes the inquiry as to the practicability of constructing a machine to deliver currents at a rate of 40,000 to 50,000 per second, such machine to be used in continuing the investigations, some of the results of which are given in his letter.

I take great pleasure in being of service to Dr. Tatum in presenting some of the results of his very able investigations, feeling sure that they can not fail to be of the highest interest to physicians, electricians, and many others. In presenting these results, I take occasion to express my sincere regret that ill health has prevented the continuance of the work in the direction laid out by the Doctor himself, and to express also the hope that he may be able to take up the further investigations at some future time.

ELECTRIC RAILWAY GUARANTEES.

BY

C. H. Radbourne

"For how long will you guarantee your armature?" "How long will you guarantee to keep the motor in repair, gears and all?"

These, or similar questions, are a bugbear to the salesman who is trying to prove the superiority of his system of electric traction to the wise manager of a street railway company. How many times I have heard them, and how many times I have wished he would not ask them.

At first sight it seems a reasonable question, and the remark, "If your company has any faith in its motor, why don't it guarantee it," is a "sticker," and apparently perhaps your inability to answer it is a negative confession that your motor will not stand a guarantee.

From all I can learn, no company to-day absolutely guarantees its apparatus against everything and anything, and yet street railway men will hang upon that clause and make life miserable while they tell you about the "sweeping," iron-clad guarantee the other fellow, your competitor, has just written in his proposal. This has been a serious question perhaps with some companies. Large contracts have been pending, and the question of "guarantees" alone was the straw or weight, as the case may be, that would turn the entire contract one way or the other.

Ought an electric company to guarantee its dynamos and motors, and if so, to what extent? If you do wish to give a guarantee, what shall be the limit, and if your competitor goes you one better, is it good business policy to break your rules and "see him" in order to get a contract?

The argument is brought up that elevators, steam engines, boilers, mowing machines, and what-not, are absolutely guaranteed for one year, and "Why should you refuse to guarantee your armature if it's any good?"

It seems to me that this question is an important one, and while it concerns each company individually, it certainly affects them all. In the first place, the question of guarantees is not a matter of much importance as relating to the stationary motors running by the hundreds in every city and town, but on the crowded street car it becomes worthy of attention. As far as dynamos for lighting and power are concerned, they come under the same head nearly as stationary motors and are more easily rated. I suppose any of our leading companies that have hundreds of dynamos in operation could tell you exactly how much the average depreciation and repairs have been, and I should be surprised if the repairs on, say, 500 of any first-class make of dynamos scattered all over the country would average 2 per cent. per annum. Absolute figures or data on motors used in street car traction are hard to obtain. So many repairs are done by the roads themselves, and so much fixed up anyhow in local machine shops, that it is extremely difficult to get at the real cost of repairs on any road.

Suppose we are asked to supply a road with, say, four 100 h. p. generators and 50 cars to be operated under normal conditions, and to state the cost of keeping the same in repair, guarantee them, etc., what shall we say? I do not believe that, in the present state of the art, any men can foretell what the cost of keeping up such a road would be within 10 per cent.

I have in mind a road that was equipped with old style motors some years ago that are running yet, as *good as new;* for three years their repairs have been practically nothing. The road has long heavy grades, the cars are crowded, *but the motors are kept as clean and well oiled as a watch.* Lift up the trap door any time, and you will see the motors as clean and bright and fresh as the day they were put in, years ago.

How many roads can show such a record? Come with me and I can show you a road somewhat similarly situated, with the same motors, and practically the same grades, which has been running about the same length of time. Look at these motors! There, they are unprotected, *covered with grease and mud,* grounded in a dozen of places; *oil and copper dust ½ inch thick all over the brush-holders,* commutators worn out and brushes set at any angle, and with tension enough to cut a bar of iron.

See the difference! One road has a wide-awake, intelligent superintendent; the other is left to look after itself.

In answer to the question, then, we can say, "First guarantee the superintendent before we guarantee our machinery."

Still another important matter remains. Granting the superintendent and his assistant are all that could be desired, even then, I say, "Don't guarantee everything absolutely."

Is it to be supposed that any steam engine builder would make an engine with moving parts no larger than a 4 inch armature pinion, making 1,200 revolutions per minute, transmitting 15 horse-power, and then place this engine where sand, water, and mud would be poured over it constantly, combined with a constant bumping and jolting, and then guarantee it *for 15 minutes?* No, he would not, and he would not be expected to, either.

I don't care how much work is put on the manufacture of a motor, if you put it under the car in dust, dirt, water, and sand, it can't wear for ever, and the chances are if it is not guaranteed it will be kept with greater care, than if it is understood "the electric company pays the bills."

Instead of guaranteeing the motors, let us instruct the men more carefully in their use. Candidly tell the manager that your motor must be kept clean and as dry as possible. Don't be afraid to tell him that your motor needs attention and proper care. He will thank you for it. There is no place where a stitch in time will save more than on an electric motor.

As far as dynamos and stationary motors are concerned, that problem is an easy one, and that brings me to my hobby, if I have one, viz., the motor car, with the motor above the axles and car floor, in a warm dry room free from dust and moisture, the gears all boxed in, the whole equipment where it ought to be, high and dry, under the eye of the motor man.

When you see a road with 50 motor cars, such as I describe, hauling open and closed cars behind them, I believe you will see a road that gives nearly perfect service, and on which the repair and guarantee question will bother no one.

ELECTRIC MOTORS TO RUN EXHIBITS IN COURT.

A one horse power slow speed Crocker-Wheeler motor was wired up in the U. S. District Court, Post Office building, recently to run a Lynotype to show its workings in a patent suit. The motor elicited much favorable comment and was handled by the judges. It is a pity the judges could not make the electric motor's closer acquaintance during the hot days of summer.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XI. NEW YORK, MARCH 11, 1891. No. 149.

Great power in the hands of ignorant or careless men implies great danger. Sleepless vigilance is the condition under which we wield all the great powers of modern civilization.—Josiah Parsons Cooke.

THE HIGH SPEED ELECTRIC RAILROAD.

THE admirable simplicity and economy of electric street railroading has already been so thoroughly demonstrated that electrical engineers not unnaturally are carrying the work forward to an extent which could hardly have been anticipated but a short time back. The simplicity of mechanism and the total absence of all reciprocating parts makes the electric motor peculiarly adapted to the operation of a high speed car, and to these features its decreased weight, in comparison with the steam locomotive, lends additional value. The experiments inaugurated by Mr. David G. Weems, at Laurel, Md., have, we believe, completely demonstrated the practicability of obtaining speeds which have not thus far been attempted in steam railroading. They have shown, above all, what the power required for this class of work is, and especially that necessitated by the high air resistance encountered. In the very interesting paper read by Mr. O. T. Crosby, before the American Institute of Electrical Engineers, we find an interesting résumé of experiments made to determine this point, which shows that under the conditions existing at Laurel, Md., the atmospheric work almost equaled the effort required for acceleration, and, that, omitting acceleration, at 100 miles per hour, the atmospheric work was something more than one-fourth of the whole. Based on the results there obtained, Mr. Crosby shows in what manner a system can be worked out for actual commercial traffic. As a departure from the general run of electric railway work, his figures present many interesting points of comparison. It is to be hoped that the capital required to demonstrate the practicability of the methods suggested may soon be forthcoming, and we believe, indeed, that that time is not very far distant.

MAGNETIC MOLECULAR VIBRATION.

THE theory of magnetism which has especially during the last ten years been the subject of much research seems to be gradually but surely drifting towards that one in which all phenomena must be explained on the assumption that a magnet is built up of magnets of molecular proportions and the action and interaction of which result in the phenomena which we observe. Many experiments have already demonstrated the change in mechanical form produced in iron and steel by a change in their magnetic conditions, such as their elongation and subsequent contraction; and by applying an inverse process of reasoning, Prof. Dolbear now shows in our columns, this week, that a change in mechanical form gives rise to a change in the magnetic conditions. As a result of these experiments he throws out the suggestion that magnetic molecules may be of the ring form, and thus brings the phenomena in close relationship with the vortex theory of atoms. The assumption of the ring form for a magnetic molecule makes it difficult to reconcile this theory with the observed phenomena of magnetic polarity, but Prof. Dolbear suggests that the ether external to the magnet may act as the medium for obtaining the effects of external magnetism.

Prof. Dolbear also carries out the interpretation of his experiments another step and offers them as an answer to the question as to how vibrating molecules set up in ether the waves which we call light. This point has never before been made perfectly clear, and therefore must be deemed one of the greatest importance in physics. Whatever the interpretation attached to these beautiful experiments, they can not fail to add another link to the chain of reasoning that leads to a final theory of magnetism.

ELECTRIC RAILROAD GUARANTEES.

IT is but natural to suppose that the purchaser of any piece of machinery will deem the question of its life and freedom from repairs one of the most important, aside from the question of efficiency, and in this respect street railway companies do not differ from the rest of mankind. Indeed, knowing them to be the conservative body of men that they are, we are inclined to think that they are, if anything, a little more inclined to investigate and diagnose all the merits of the apparatus which they use, than is generally the case. It is not to be wondered at, therefore, that when a railway company is about to purchase electrical apparatus, one of the main questions entering into the negotiations is the life of the motors and the repairs which they will require. The question of what the guarantee shall be in this case is very ably discussed in another column by Mr. A. H. Chadbourne, who takes up both sides of the question, and, we think, finds the true solution for this vexatious problem. It has come to be generally recognized that even automatic machinery of the highest order requires more or less personal supervision for its proper operation. What then, as Mr. Chadbourne points out, can any guarantee of electric railway apparatus amount to, when the latter, normally subjected to the hardest kind of work, is not kept in proper working order? Although companies operating electric railways have not yet by any means generally adopted the practice of employing competent electrical engineers to supervise their apparatus, it is only a question of time when such will be the case. No matter how well the apparatus may be designed and operated, none but the most intelligent supervision can maintain it in proper working order, and the sooner this is recognized the better for both the seller and the purchaser of electric railway apparatus. We believe that in this respect the manufacturers of electric railway apparatus can do much, not only to lighten their own burdens, but to place electric railroading in the position it ought to occupy, namely, beyond the criticisms which are brought about by sheer neglect of the most ordinary precautions. Mr. Chadbourne, it will be noted, still favors the idea which was early applied in the art, namely, that of placing the motor on the car platform, away from the street bed and completely protected from all disturbing influences. This method undoubtedly has advantages in a certain direction, but the question of the method of gearing the armature to the axle was, we believe, the chief difficulty to contend with in this arrangement and it finally led to the adoption of the means now in general use for that purpose. But the objections which have been raised against placing the motor under the car have been largely removed by the adoption of motors and gears which are entirely enclosed.

ALTERNATING CURRENTS OF HIGH FREQUENCY.

It has more than once been suggested that if we could but construct an alternating machine capable of giving us a frequency of alternations approximating to that of light we should be able to obtain luminous effects without the accompaniment of heat, and thus obtain an ideal method of illumination. Unfortunately, the limits of the strength of materials, and of the mechanical and electrical means at our disposal, have thus far made the realization of this suggestion impossible. Recent experiments have shown, however,that even with a frequency of alternation far below that assigned to the light producing waves, important luminous phenomena are observed, and in a recent article Mr. Nikola Tesla gives the results of some remarkable experiments effected with an alternating current of 20,000 reversals per second. In these the condenser action of lamps and conductors is very forcibly brought out, and points to the fact that the condenser will play an important part in the methods of distribution of light in the future, if not, indeed, of power. Referring to the same subject, Prof. Elihu Thomson, in our columns this week, gives results of experiments made in the same direction, which cannot fail to to draw attention again to this subject, and which, taken in connection with the recent inaugural address of Prof. Crookes, illustrate forcibly the tendency of modern work in the attempt to obtain light without heat. Prof. Thomson also contributes a valuable note on the physiological effects of alternate currents of high efficiency, in which it is shown that at very high rates the current is less dangersou than at the lower rates now in vogue.

EUROPEAN ELECTRIC RAILWAY PRACTICE.

Electric railroading may, we think, justly be called the product of American genius and labor, and this belief is confirmed by the general adoption of American devices in the construction of similar apparatus abroad. Heretofore, our kin and friends across the sea have adopted arrangements which have already proved successful with us, but in some recent work they may be said to have gone a step beyond our own practice and put into practical operation methods that have been suggested here, but which, up to the present, have not gone into practical operation. We are led to this observation in contemplating the methods adopted in the construction of the Buda-Pesth conduit railroad. As stated in another column, the design here approved is essentially that advocated by Mr. Stephen D. Field, some years ago, and its successful operation is, we think, a good indication of the soundness of Mr. Field's ideas on this subject. It is to be hoped that some of our own roads may take up this method at no distant day.

Re-Starting of the Deptford Station.

The unfortunate interruption of the work from the Ferranti station at Deptford, some three months ago, due to a fire at one of the distributing stations, caused by a very careless workman, called forth, as might have been expected, some unfavorable comment at the time, but no one who is at all acquainted with Mr. Ferranti or those connected with him, can for a moment have doubted that in a comparatively short time the damage would be repaired, and the station be again in full operation. This has already come to pass. The station, as we note by English exchanges, has been started up again, and will, no doubt, successfully perform the work for which it was designed. The character of the work planned, and now being carried out by Mr. Ferranti, is such a radical departure from previous practice that it is to be expected that obstacles will be met with and new phenomena developed which have heretofore not come under the observation of electrical engineers, and for which, necessarily, no provision could be made; but once their nature is ascertained, a remedy must follow as a natural course, and thus the work will be carried to a successful consummation.

Municipal Ownership of Subways.

The question of the municipal ownership of subways has been brought up in New York by the proposition to wipe out of existence the old Board of Electrical Control, create a new Commission, authorize the spending of $3,000,000 of city money yearly on municipal subways, and supersede by purchase, or compensation, the subway system now operating. There are merits in the plan, but one always feels slow to approve any scheme that adds to the means of expenditure and sources of income under political management or control. What is really wanted is a plan of common subway construction that will give everybody a chance to run wires under proper rules and at a fair rental, and will prevent the streets from being in an everlasting state of upheaval and blockade. But to reach this end it is not necessary that the city should invest taxes in the work.

REPORT OF HIGH-SPEED ELECTRIC RAILWAY WORK.[1]

BY O. T. CROSBY.

THE experiments here reported were the first serious efforts ever made to at once double railway speeds, and as such should, I think, be systematically recorded.[2] They were made for the Electro-Automatic Railway Co., of Baltimore, Md. This company was organized about four years ago by Mr. David G. Weems, who, though not an engineer, was convinced that the electric motor would give very high speeds for the transportation of parcels. His persevering enthusiasm resulted in inspiring a number of gentlemen to subscribe money for the venture.

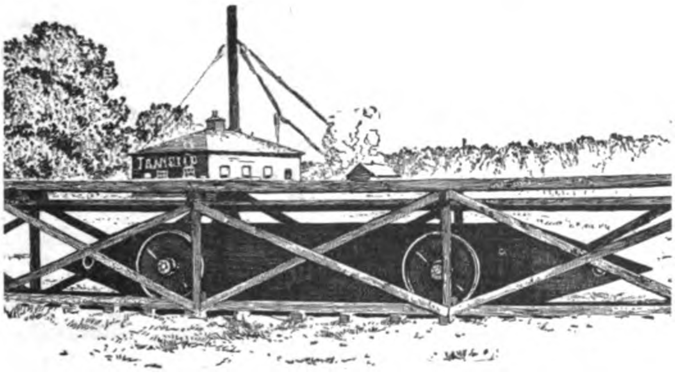
FIG. 1.—THE WEEMS HIGH SPEED ELECTRIC RAILWAY, AS OPERATED AT LAUREL, MD.

Mr. Weems first contemplated having an entirely automatic service from city to city, the cars to be smaller than would be necessary for placing a man. The experimental motor and track are shown in Fig. 1.

For purpose of demonstration, a circular track nearly two miles in circumference, was laid at Laurel, Md.; gauge, 28 in.; weight of rail, 16 lbs.; shape, **T**; cross-ties, 3x4 in. square, 16 ins. apart. Wooden stringers 3x4 ins. were laid outside each rail, serving as guards. Mud-sills 3x4 ins. were laid under the ties, and to the ties was built up a vertical frame-work on both sides of track, this carrying from 2x6 in. cross-pieces a wooden stringer, suspended above the middle of the track, while to the lower surface of the stringer was attached a small **T** rail, head down. This upper rail was intended to serve as an electric conductor, and also, in connection with upward pressing wheels, as a guide. The latter function was not successfully performed, the lateral oscillation of the car, on so slight a track, being too great. Part of the track was on trestle-work crossing a swamp, the overflow of which caused frequent wash-outs.

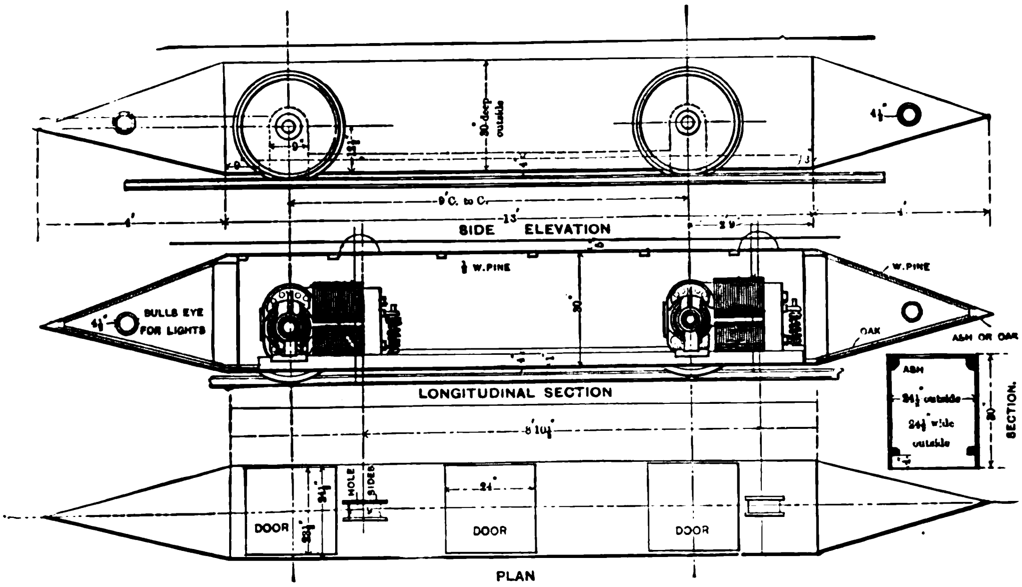

FIG. 2.—THE WEEMS ELECTRIC LOCOMOTIVE.—ORIGINAL PLAN.

The locomotive was very simple. Three axles carried 28 in. wheels; on these were hung a steel box, 16 feet long x 24 ins. high x 30 ins. wide. A slight vertical play of the box was provided for by springs, but, horizontally, the three axles were in rigid connection. On each of these axles it was designed to place a motor. The head was pyramidal; the weight of the car with three motors was about three tons. A second similar box of steel was made to be drawn by the motor-car, the two to be connected by a ball-and-socket arrangement, the interval between cars to be flanged over so that only one surface should be presented to meet atmospheric resistance. The tail was pyramidal. The second car was not in use more than once.

The track-work and cars were completed as above outlined when the matter was brought to the Sprague Electric Railway & Motor Company, with the request that they design motors of which the armatures should be placed directly on the three driving axles of the car, the construction of which was already nearly finished. It was further conditioned that the motors should do 20 h. p. of work, each, at a normal speed of about 3,000 revolutions per minute. This corresponds to a car-speed of about 250 miles per hour. Needless to say, that on so light a track, none of which was straight, and with a car weighing three tons, and with only 60 h. p. available for work, no such speed was attained. The motors were carefully designed by Mr. H. F. Parshall, of the Sprague Company, for a normal impressed E. M. F. of 500 volts, and thoroughly filled the specifications. They were to be connected in multiple across the 500-volt circuit supplied with current from a dynamo made by the Edison Machine Works. When the motors were finally mounted and ready for action, it was found almost impossible to start the car, due probably to stiff bearings, and when several trials of speed had been made, the results were disappointing.

Up to this time the electrical work had received only such engineering attention as could from time to time be given by employees of the Sprague Company, much occupied in other ways. It became evident to the Baltimore company that any satisfactory accomplishment could be had only through the continuous attention of some one having had electrical experience.

As superintendent of the Sprague Company, I had been familiar with the manufacture of the motors, and had moreover visited the plant; hence in October, 1889, it was arranged that further experiments should be under my direction. Throughout the work Mr. B. J. Dashiell, Jr., M. E., and Mr. H. F. Purdy, of the Sprague Electric Company, were of constant assistance, both in conception and execution of all that was done.

Work having been resumed, it was soon found that a given speed could be attained with less current if two motors were in service than with three, and consequently the motor on the middle axle was removed. It seems probable that, when running, this middle motor was largely occupied in skidding the wheels driven by it, since the two outer axles, on a yielding track, would doubtless support the greater part of the weight. In any case, the two motors were able to produce a greater speed than the track could stand. These machines were of the **U** type. The armature was wound with 100 sections of No. 12 B. W. G. wire, each section of two turns. This armature, with its commutator, was rigidly mounted on the axle. The pole-pieces were attached to brackets centered on the axle, the keeper was spring-supported on a cross-piece carried by the steel casing. Bearings were of phosphor-bronze and lubrication by oil from an ordinary cup. No trouble on this score was experienced. Each magnet core was wound with 120 turns of No. 4, B. W. G. wire. At 30 amperes the armature induction was about 80,000 lines per square inch. Outline of the motor is shown in Fig. 2. These motors, since wound, according to specification, for the 500 volt circuit, were originally connected in multiple arc. This connection was changed, they being placed in series, thus diminishing the potential-control, required at the station by reason of the fact that the machines were run at a speed so much below that for which they had been calculated.

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[1] A paper read before the American Institute of Electrical Engineers, New York, February 24th, 1891, President W. A. Anthony in the chair.

[2] Pressure of other work has prevented me from carefully reviewing the calculations appearing in this paper.—O. T. C.

To supply the current, contact was made between the upper rail and brushes of sheet copper set against the rail by springs. These served their purpose well. The return circuit was through the wheels and rails, the steel casing being insulated from the axle by fibre plates and washers at joints and bolts. Rail bonds (covering joints in upper and lower rails) were used throughout; the resistance of the external circuit from the feeder junction to a point diametrically opposite was about 0.25 ohm.

The station was placed inside the circle, about 200 feet from the track. The generator was a 70 h. p. Edison machine, not compounded originally, and was driven by a 90 h. p. high-speed Ball engine. At first a wire resistance of about 12 ohms was used to lower the potential on the line, as it was not convenient to run the dynamos at less than 400 volts. Later, a whiskey barrel was filled with water, an iron plate, 8 inches square, was placed in the bottom, a similar plate was fixed to the end of an iron rod and this rod attached to the pulley, permitting easy lifting or dropping of the plate through the water. These plates being connected in the main circuit, a very serviceable liquid rheostat resulted, which, when "taken with a grain of salt," answered excellently the purpose of regulating currents which often went as high as 150 amperes.

The usual course of a run was this. Speed-observers, as many as could be had, up to five or six, were stationed around the circle, distance apart being known. Watches of these observers and of recorders who read current and potential were compared. Potential readings were taken at station and at one or two points on the line, permitting easy reduction to horse power. Mr. Dashiell, my assistant, then took the engine and I managed the dynamo. A current of from 20 to 40 amperes usually started the car. The size of the armature wires limited to about 90 amperes—45 in each machine—the current permissible for any length of time. This value was usually attained in the first half mile of run, a considerable part of the external resistance having been cut out. When the car had attained a speed of 75 to 100 miles per hour, the line potential was in the neighborhood of 450 volts, the iron plates in the barrel being in contact, having been slowly approached as the counter E. M. F. increased. The time limitation of the runs was invariably caused by failure of the track to serve its purpose. On three occasions the car left the track; once at 45 miles per hour, once at 80 miles per hour, and once, the last time, at about 115 miles per hour. Curiously enough, on the two former occasions the derailment was to the inside of the circle, superelevation being about four inches.

It was easy to tell in the station when a derailment was immi-

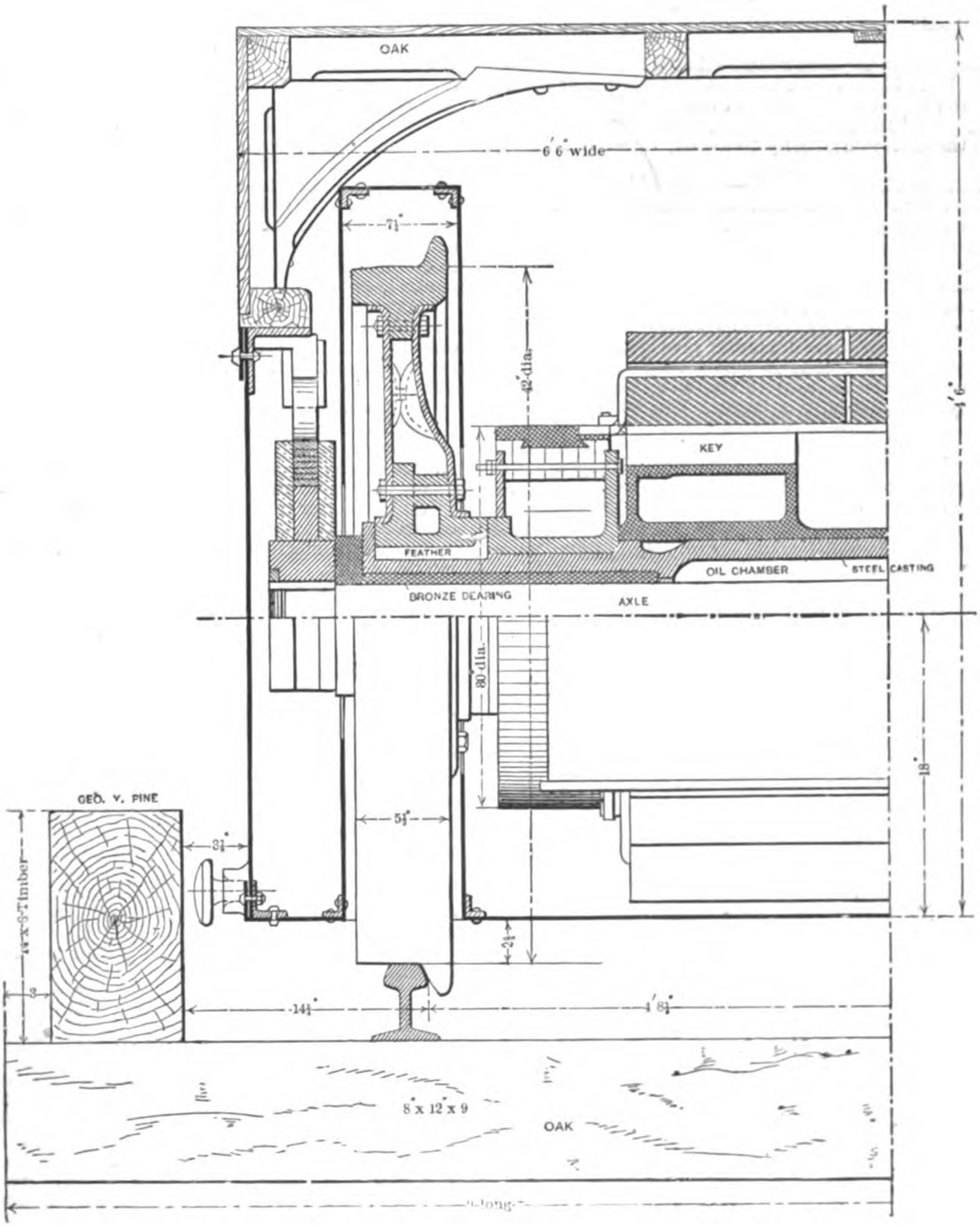

FIG. 3.—HIGH SPEED ELECTRIC LOCOMOTIVE.—HALF CROSS-SECTION.

nent, as the ammeter was most violently agitated by the make and break of the circuit caused by the particularly bad spots in the track. The agitation increased with each trip around the circle and ended in a run-off, or, after some experience had been gained, in a cessation of the trial. As the track limited the length of run in time, so also it limited the speed obtainable. Each trial—the longest being about twenty-two minutes' consecutive running—was followed by an overhauling of the track, requiring from a few hours' to a week's work by four or five men.

Could the experiments have been made on a road-bed and track, deemed even second-class according to steam railway standards of rail-weight, etc., there can be no question that without any other change, the car could have maintained for several hours a speed of 120 miles per hour. Indeed, I know of no time limitation that would have arisen save that from a limited oil supply.

The speed obtained in the first round—that is in the first 9,240 feet—varied from 30 to 75 miles per hour; this determined by the management of the rheostat. The *rate* of acceleration from point to point in going round the circle was irregular, due to the grades which, going in the direction usually followed, varied from 2.0 to 2.5 per cent.

The fact that the track—always bad—went rapidly from bad to worse during each run, made it difficult to analyze the records with a view to determining the true coefficient of traction. Moreover the coefficient for such a track, even in its best condition, would be greater than for the track that would necessarily be built for actual service. The figures obtained were of little worth as far as fixing absolute values at very high speed, but at least served to show the error of many train resistance formulæ found in the text-books. Some of these formulæ give good enough results when used for the low speeds on which they are based, but their algebraic form is such as to give rise to great error when higher speeds—say, 80 to 120 M. P. H. enter. This whole matter of train resistance has been more fully treated in a paper, "Limitations of Steam and Electricity," read by me before this Institute on May 21, 1890. (See THE ELECTRICAL ENGINEER, May 28, 1890, p. 395). The particular element of atmospheric resistance, for which special experiments were made at Laurel, was fully treated in a paper read by me before the West Point branch of the Military Service Institute, and published in London *Engineering*, issues of May 31 to June 13, 1890.

Using for atmospheric resistance, figures resulting from the experiment herein referred to, we may analyze thus:

RUN OF OCTOBER '89. FLAT HEADED CAR.

Time of 1st round, 3.8 minutes, Av. speed = 2430 F. P. M. = 28 M. P. H.
" 2d " 2.8 " " = 3300 F. P. M. = 37.4 M. P. H.
Average rate of work done by motors in 2d round = 15.0 H. P. 495,000 ft. lbs. per min.
Average horizontal effort in 2d round = 495,000 ÷ 3,300 = 150 lbs.
" " " " " for atmospheric resistance = 30 lbs.
" " " " " for acceleration (approx.) = 10 lbs.
" " " " " for other resistances = 110 lbs.
" " " " " per ton = 110 ÷ 2.4 = 46 lbs.

RUN OF NOV. 13, '89. FLAT HEAD.

Time of 1st round = 4.25 minutes. Av. speed = 2170 F. P. M. = 24.7 M. P. H.
" 2d " = 2.5 " " = 3700 F. P. M. = 42.0 M. P. H.
" 3d " = 2.5 " " = 3700 F. P. M. = 42.0 M. P. H.
Average rate of work from middle of 2d to middle of 3d round = 15.5 H. P. = 511,500 ft. lbs. per. min.
Average horizontal effort = 511,500 ÷ 3700 = 138 lbs.
" " " for atmospheric work = 36 lbs.
" " " for acceleration = 0 lbs.
" " " for other work = 102 lbs.
" " " per ton = 102 ÷ 24 = 42.5 lbs.

RUN OF NOV. 13, '89. PYRAMIDAL HEADED CAR.

Time of 1st round = 4.0 minutes. Av. speed = 2410 F. P. M. = 26.2 M. P. H.
" 2d " = 2.0 " " = 4620 F. P. M. = 52.4 M. P. H.
" 3d " = 2.25 " " = 3678 F. P. M. = 41.8 M. P. H.
" 4th " = 2.25 " " = 3678 F. P. M. = 41.8 M. P. H.
" 5th " = 2.25 " " = 3678 F. P. M. = 41.8 M. P. H.
" 6th " = 2.25 " " = 3678 F. P. M. = 41.8 M. P. H.
Average rate of work in last four rounds = 16.0 H. P. = 528,000 ft. lbs.
" horizontal effort = 528,000 ÷ 3678 = 144 lbs.
" " " for atmospheric work = 24 lbs.
" " " for acceleration = 0 lbs.
" " " for other work = 120 lbs.
" " " per ton = 120 ÷ 2.4 = 50 lbs.

[illegible]

[illegible]

and we have:

Average speed = 8,800 F. P. M. = 100 M. P. H.
" horizontal effort = 44 x 33,000 ÷ 8,800 = 165 lbs.
" " " for atmospheric work = 48 lbs.
" " " for other work = 117 lbs.
" " " per ton = 117 ÷ 2.4 = 48 lbs.

Highest speed attained this run = 110 to 120 M. P. H. Track better than in last run, but car was derailed at maximum speed.

These values, 46.0, 42.5, 50.0, 58.7 and 48.0 lbs., should be corrected for curvature, making them, 30.7, 28.4, 33.4, 39.1, and 32 lbs., respectively. Other and lower values were obtained when the track, as at first, was in better condition. But these earlier runs were not recorded in exact figures. The rails were in all cases rusty.

The speed at which this derailment took place could not be absolutely determined, since the car left the track at some distance from the last two observers, whose time records gave the speed attained between the points of observation. It was clear, however, that final speed was between 110 and 120 miles per hour. A length of 1,000 ft. of track was injured, about 300 ft. of the upper framework wrecked, and the car itself was landed about 30 ft. from the track, having finally jumped the guard rails while going over a fill 4 or 5 ft. high. It seemed clear that the Laurel plant had passed its days of usefulness. Nothing further of value could be done without practical rebuilding. It was then time to make new plans, and this work was at once begun by Mr. Dashiell and myself. At the outset I felt that—if for no other than commercial reasons—we should plan for the carrying of passengers as well as parcels. This meant an increase in the size of cars and a change from an attempt at automatic control, to control by human intelligence on the locomotive.

For purposes of demonstration I proposed to the company that they should build a track about four miles (not less) in circumference and should run thereon a train of two or three cars drawn by one locomotive. Calculations were based on the following data:

(1) A speed 150 miles per hour on a level was to be aimed at.

(2) Cross-section of car should be a minimum, consistent with the seating of passengers. This was taken at 6 ft. by 5 ft. 30 sq. ft. (crowning higher along middle of car).

(3) Gauge of track should be standard—4' 8.5".

(4) Character of track should be simply the best that art could contrive, rails to be from 65 to 90 lbs.

(5) Electromotive-force should be as high as the art of insulation would permit.

(6) Whatever might be the number of cars in a train, all were to be so connected as to present a continuous exterior, thus presenting only one cross-section to the atmosphere.

(7) Atmospheric resistance at 150 miles per hour would be taken at 15 lbs. per square foot of cross-section, a wedge or parabolic locomotive head being used. This value is 50 per cent. in excess of that indicated by our experiments.

(8) Traction coefficient, exclusive of air resistance, would be taken at 150 miles per hour, to be 35 lbs. per ton—this for reasons set forth in previous papers.

From the two resistance coefficients just given, it followed that for every square foot of cross-section, regardless of weight, 6 horse power would be required, and for every ton of weight, regardless of cross-section, 19 horse power must be supplied.

For a locomotive of about 600 horse power having 30 ft. cross-section, the dead weight was calculated to be about 18 tons. Steel cars of equal cross-section were designed, weighing, empty, about 5 tons, with carrying capacity of about 5 tons.

The important question as to power required could then be thus tabulated:

	150 M. P. H.	120 M. P. H.
Locomotive alone	300 H. P.	228 H. P.
Locomotive and one car loaded	400 "	300 "
Locomotive and two cars loaded	500 "	446 "
Locomotive and three cars loaded	600 "	525 "

To perform the work here indicated two motors were provided, one armature directly on each of the two axles of the locomotive car. These motors, outlined in Figs. 3, 4 and 5 were of the Manchester type. They were supposed to be at first connected in multiple arc across a [illegible] volt circuit, each taking about 130 to 150 amperes and delivering about 250 to 300 horse power. Should it be desired to experiment with higher line potential, the motors in series would permit [illegible] volts to be easily tried. The armatures of the Gramme type are [illegible] in. outside, 23 in. inside diameter. The armature conductors were to be of about 40,000 circular mils cross-section, or [illegible] to 300 c. m. per ampere. Many successful machines, designed to work indoors, go as low as this figure, and since the dissipation of heat must in such case proceed more slowly than in the case here considered, the figure seemed very safe. Moreover, it was intended to introduce a blast of air from the car front which should continuously flow through the open [illegible] of the armature ([illegible] type). How far the rate of dissipation would be effected by such means can not now be known. [illegible] experiments of Mr. Kennelly) goes to show that the [illegible] capacity would be much increased.

The cross-section of [illegible] in the armature was 3.5 x 40 = 140 square inches gross, [illegible] 15 per cent. for paper insulation [illegible] per cent. for commutator slots [illegible] square inches net. Through this armature it was desired to force 22,000,000 lines (C. G. S. units) or 100,000 per square inch = 15,000 per square centimetre.

The hysteresis loss in such armature revolving at 1,200 R. P. M. (equivalent with 42 inch wheel to 150 M. P. H) was calculated to be about 3,000 watts—following the curve published by Esson. The $C^2 R$ loss ($C = 135$ amperes, $R = 0.26$ ohm when $T = 75°$ C) = 4,740 watts,—or about 8,000 watts for the two losses. I found it difficult to obtain such coefficient as would give reliable values for loss due to Foucault currents. With very thin plates it would not be large. From what precedes, it followed that the number of armature conductors should be 340. These were divided into 170 sections, wound in one layer, each conductor to lie in a slot; both slot and conductor were planned to be rectangular, or nearly so, with the reservation that experience in manufacturing would soon show the proper detail.

The magnets have a cross-section of 164 square inches, through which 14,300,000 lines of force must pass, the increase from the number in the armature being determined by a leakage coefficient 1.3.

The magnet coils of the two armatures were calculated to be in series with each other, but in shunt with respect to the two armatures. This variation from present street car practice I thought to be justified by the following considerations: First, no system of commutation could obviate the need of a considerable external resistance, which then could be easily made sufficient, within itself, for speed control; second, the maximum torque for a given armature current is always desirable and can be best obtained by permanent saturation; third, this constant and maximum magnetization would tend to diminish sparking—an evil to be specially avoided in long distance work, involving continuous runs of several hours.

While it was thus intended to use shunt coils at first, I felt that a little experience would soon positively demonstrate that the advantage lay with this or the series winding.

The commutator, Fig. 3, was designed to be 23 inches in diameter, which would of course give rise to a very high speed relative to the brushes. I believe it better to face the mechanical trouble that might be connected with great circumferential speed, rather than to diminish the diameter by decrease of sections, since this in turn might produce sparking.

Without going into the mechanical details of the commutator, I may add that a single bar could be taken out or replaced, without removal from the shaft.

The rheostat for the armature circuit was designed to be of iron wire, with the expectation however of experimenting also with liquid or carbon resistance. The resistance and heat capacity of this main line rheostat were determined with reference, first, to current necessary for starting, second, to currents needed for maintaining low speeds. The starting current on practically level track was calculated to be from 300 to 400 amperes, the load being 80,000 lbs. (or locomotive and three loaded cars). For continuous running at 30 miles per hour, a current of 40 amperes would be required, the counter E. M. F. of each of the 1,500-volt motors being, at this speed, only 320 volts. The line-potential being 3,000 volts, it would be necessary to have in the armature circuit an external resistance of 59.0 ohms $= \frac{3000-640}{40}$. The wires were calculated to stand 40 amperes continuously, and the various sections were proportioned to stand the various currents for such time as would serve to bring the train up to speed. It was, of course, known that a considerable reduction in the size of resistance box could be effected by winding the motors for the regular line potential, thus normally working them in arc, but putting the armatures in series where a great reduction in speed might be required.

A small rheostat and a condenser were designed to be placed in the circuit of the magnet coils, and a rheostat also in the lamp circuit, these resistances giving delicate control.

The problem of retardation for a mass of say 40 tons running at 150 miles per hour is a serious one. The Galton and Westinghouse tests indicate a very low value for the coefficient of friction between brake-shoe and wheel, at high speeds; they report it in some cases at 60 M. P. H. as low as 0.04. As, however, it rapidly increases at lower speeds, an average of 0.1 may be taken. The total retarding effort, *i. e.*, brake resistance and track and atmospheric resistance, must be kept below that which will just produce sliding of the wheels, and the coefficient of sliding may be taken on an average at 0.08 of the weight of the wheels. If then we represent by P the maximum allowable brake pressure on the wheels, by R resistances other than brake friction, and by W the weight on braked wheels, we may write the following inequality: $0.1 P + R < 0.08 W$.

The value of P should be determined as that which, with a small margin, will satisfy this condition of inequality.

Following this calculation, it was found that a brake-pressure of about 5,000 lbs. should be applied to each wheel. This was designed to be produced by magnetic brakes similar to those used by Mr. Daft on the New York Elevated Railway. The form and approximate dimension of those brakes are shown in Fig. 4.

A mass of 80,000 lbs. moving at 150 miles per hour represents 64,000,000 foot-pounds of energy. Average resistance due to brakes = 0.1 x 60,000 = 6,000 lbs. Average resistance from track and atmosphere for average speed of 75 miles = 400 lbs.

In addition, the motors may be required to generate a current which shall be wasted over the rheostat. Since the field-circuit in the case of shunt-motors, is independent, magnetization may remain constant, and average E. M. F. of 1,500-volt motors (*i. e.*, motors generating 1,500 volts E. M. F. at 1,100 R. P. M. or, with 42″ wheels, at 150 E. M. F.) would be, while the train was coming to rest, 750 volts. Make the external resistance such, that the two armatures being in series, an average current of 200 amperes shall flow. Then, average dynamo resistance, in lbs. = 2,000. Total retarding effort = 6,000 + 400 + 2,000 = 8,400 lbs. Dividing 64,000,000 by this last quantity, we have 7,620 ft. as the length of run to come to a stop, and the time of stopping about 100 seconds.

For the mechanical construction of the locomotive, two plans were contemplated. One has a 12-foot rigid wheel base and no pilot wheels; the other has a 7-foot wheel base for the drivers and a pony-axle in front, free to move laterally over a certain distance, dragging the drivers in the same direction. This is the general principle of pilot-wheels, so largely used on high-speed engines. This second arrangement, Fig. 5, is preferred. In it nearly all the weight goes on the drivers. In this particular case, total weight of locomotive is about 18 tons, each motor being six tons. Of the total, 15 tons rest on the drivers. If then the adhesion-coefficient, while running, be taken at only 0.1, a circumferential effort of 3,000 lbs. may be exerted without slipping the wheels. This is safe, since if 600 h. p. of work be required at 150 miles per hour (= 13200 f. p. m.), the horizontal effort $= \frac{600 \times 33{,}000}{13{,}200} = 1{,}500$ lbs. For starting the load, adhesion-coefficient may be taken at 25, giving 7,500 lbs. possible pull, this being much in excess of the value required.

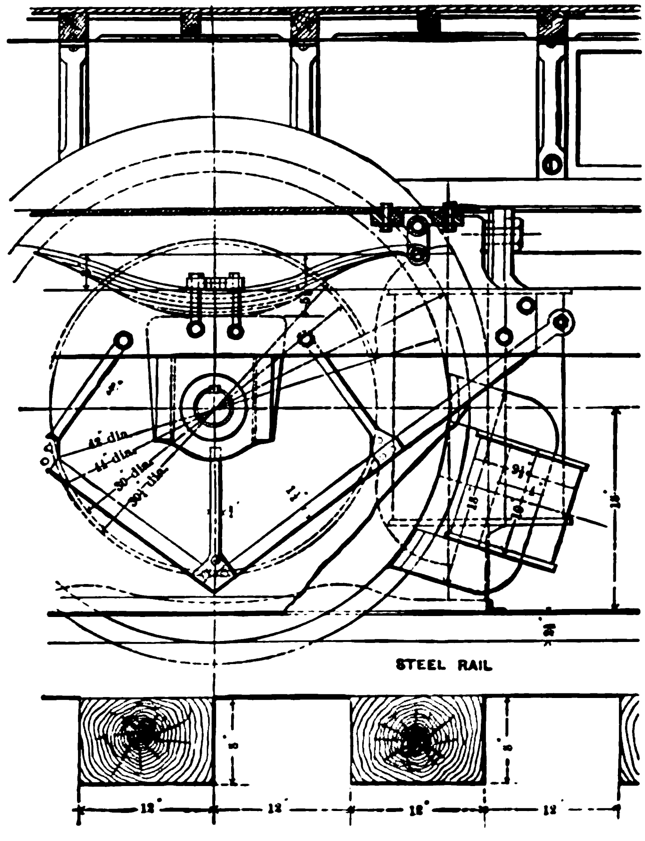

FIG. 4.—HIGH SPEED ELECTRIC LOCOMOTIVE.—BRAKE MECHANISM.

The locomotive construction is such as to put the entire weight of the armature directly on the axle. In designing this, I did not overlook the fact that the armature must thus be subjected to much jarring. But I believe the difficulty should be met by excellent mechanical construction, rather than that spring movement should in any way be attempted. For mechanism that shall succeed in high speed, long-time service, simplicity is a requirement of the first order. Indeed, generally, in this work of connecting an electrical motor to any vehicle, I have long felt that he who is over-ingenious in contriving many parts and fine adjustments, may not be over-successful.

The weight of the magnets and pole-pieces goes also directly on the axles, save for the intervention of rubber plates having a maximum play of 1-16 of an inch. By the use of motors of the "**U**" type, part of the weight might be spring-supported, but on the other hand it is not as easy, with that type as with the Manchester, to obtain a perfectly sparkless motor. Moreover the weight going dead on the axles in the case considered, is not greatly in excess of that due to 8-foot drivers and other attachments of large steam locomotives. Further the need of any spring movement decreases with increasing perfection of track-work, as, in an ideally perfect track, car-springs would not, save on curves come into play.

In the first design of locomotive cars, the operator is to sit between the two motors, where also would be placed the controlling devices. In the second design, the operator would be placed over the pony-axle, the devices being chiefly in the cylindrical or parabolic head.

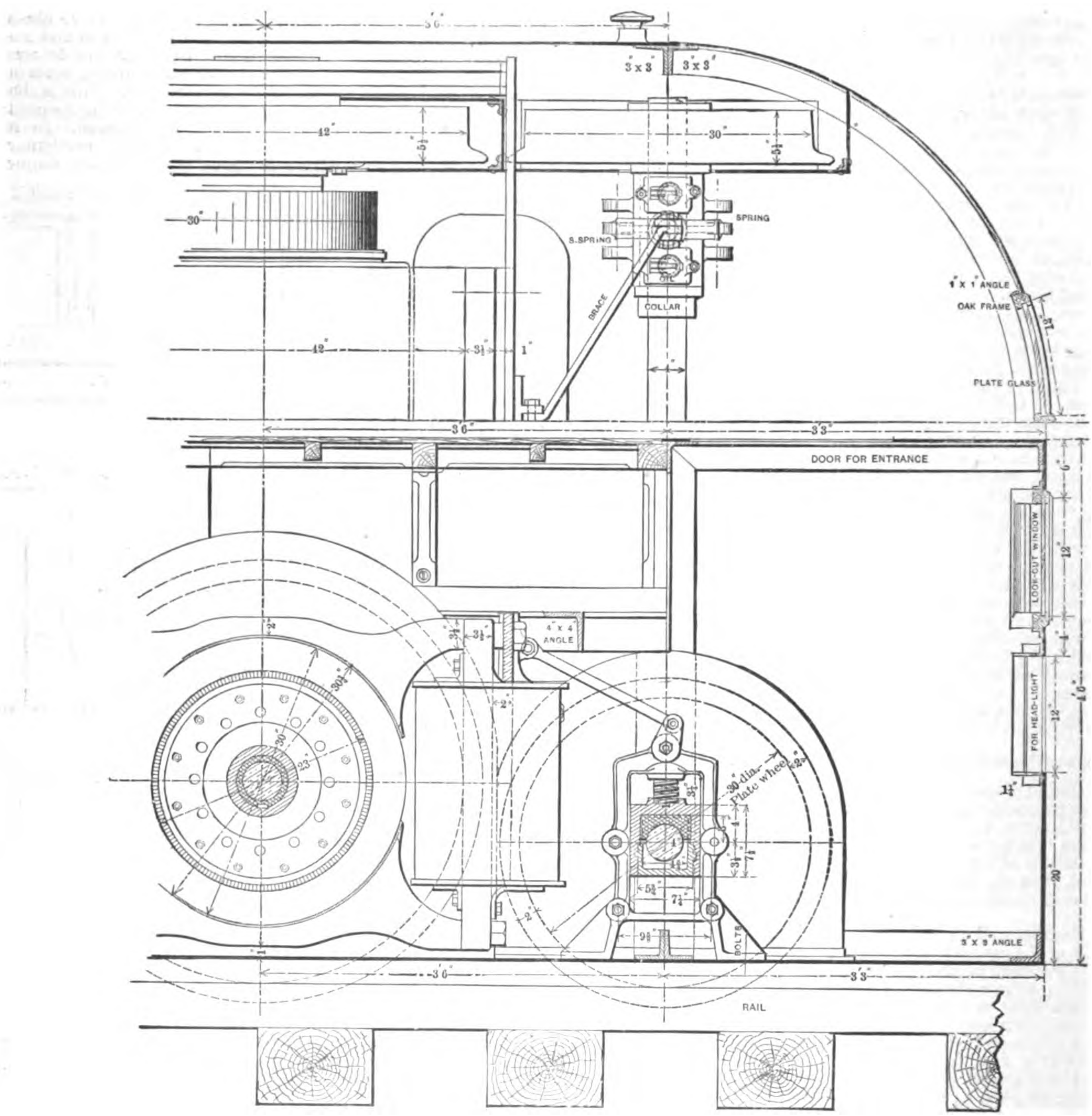

Fig. 5.—High Speed Electric Locomotive.—End of Car, Elevation and Plan.

Detailed drawings of freight and passenger cars were completed, but need not here be referred to.

As to the supply of current, it is proposed to use the double metallic system. This departure from the ground return, now so commonly employed in street railway work, seems justified by the following considerations:

1st. For a given voltage it diminishes the cost of insulation, per se.

2d. It diminishes the danger of accident within the motors.

3d. It diminishes danger of accident to workmen.

4th. By being thus more easily handled, it is probable that a higher voltage will be found practicable than with the ground return; hence, in fact, even first cost might not be greater.

As designed, the conductors will be placed in an inverted wooden trough, attached to posts placed at 12 feet intervals on each side of the track. The trough to be about 5.5 feet above the ground. The conductors for each side of the circuit to be two—one insulated and continuous; the other a bare, flat strip, broken into sections, these being normally out of circuit; the locomotive trolley-arm operating a switch which shall throw out the rear section, and throw into circuit the section ahead. Such a switch was designed in detail.

As to what the line voltage should be, progress in the art of insulation can alone determine. It would, of course, not be necessary, on a roadway for long-distance travel, to consider the death-producing voltage as a limitation.

In the important matter of limiting curvatures, calculations were made in the ordinary way, using the particular values for weight and height of centre of gravity. A safe speed was then tabulated as that which is just one-half the speed that causes the resultant of weight and centrifugal force to pass through the outer rail of a curve. The beneficial effect of superelevation, neglected in the calculation, would, of course, practically increase the factor of safety.

The following table resulted from the method described:

Radius in feet.	Safe speed, by rule above, in miles per hour.
1.000	71
2.000	98
3.000	120
4.000	140
5.000	158
6.000	172
7.000	187
8.000	198

Of course, naught save practical trial could determine whether the assumed factor of safety, which is quite large enough at present speeds, would, in fact, be right for the higher speeds aimed at.

COMMERCIAL ASPECTS.

Copper calculations were made, based on a station potential of 3.000, and also of 6,000 volts, stations being 50 miles apart (thus supplying current 25 miles on each side) and on a service requiring one train on each 25 mile section, the drop on the line being 33% of station potential. Then for a line of 1,000 miles, as from New York to Chicago, with copper at 15 cents per lb., and for 3,000 volts initial:

	Per mile.
Cost of conducting system, including frame work - - =	$ 7,000 00
" station per mile, including steam - - - - - =	3,000 00
" double track, including depots, etc., - - - =	55,000 00
" train equipment, 3 cars each, 50 trains and engines =	1,000 00
Total per mile - - - - - - - -	$66,000 00

In this, the cost of track construction is based on road-bed figures reported for the Erie Railway Co. To arrive at operating expenses, suppose 20 trains each way each day, and a schedule of 125 miles per hour, *i. e.*, 8 hours for the trip. Suppose a station development of 800 h. p. per train on the line, or 64,000 h. p. hours per trip. In stations of large capacity working under the supposed conditions, the cost of one h. p. hour = 0.90 cent (see tables in previous paper "Limitations of Steam and Electricity") or per trip, for power a cost of $57.60. For train men, suppose two men on each train, and one per train in reserve, and suppose $3.00 per man per trip of 8 hours, then, cost per train trip = 3 × 3 = $9.00. Interest charged per train trip =

$$\$66,000,000 \times 0.05 \div 365 \times 40 = \$225.42.$$

For maintenance of way (see Wellington's Statistics), take $1,000 per mile of double track per annum, or per day for supposed line, $2,700.00; or per train trip, 2,700 ÷ 40 = $67.50. For general expense of operating company, suppose $1,000.00 per day—or per train trip $25.00. For wear and tear, oil, etc., on train itself, take $10.00 per trip. Then total = 56.60 + 9.00 + 225.42 + 67.50 + 25.00 + 10.00 = $394.42.

For receipts:

Suppose average train be of two cars (such as designed) having each a capacity of about 10,000 lbs. freight (considered such, as express and mail matter), or of say 15 passengers. Suppose average train load of freight, 15,000 lbs., of passengers, 20. Take freight at 33 cents per cwt., passengers at $25.00. The income per trip in either case—$500.00, showing profits, over fixed charges, of say $100.00 per trip, or $4,000.00 per day. The total daily load of freight, each way, required to justify the service above treated, is 300,000 lbs., or if 200 through passengers be carried (*i. e.* ten trains for passengers each way each day), then only 150,000 lbs. of freight. The *present* movement between New York and Chicago, in mail and express, is not far from this figure. A five-hundred mile line, connecting Boston, New York, Philadelphia, Baltimore and Washington, would be even more profitable. It is to be remembered also that a service of *small* trains is contemplated, making fixed charges relatively very large. Much larger trains could be, and I think *will be*, run at the speeds here considered, but I have supposed that the smaller effort would precede the larger. It is further to be noted that the use of 6,000 volts potential, and the extension of some existing roadway instead of the building of a new one, would diminish first cost. As grade-crossings would be out of the question, and as cities would require to be entered above or below the surface (country roads to be carried over on bridges), it is perhaps best to consider only the larger figure already used.

To demonstrate all or nearly all that has been outlined in this paper will cost about $300,000, covering the construction and operation for a reasonable time, of the four-mile circular line proposed above. Last year the Baltimore company met unexpected difficulty in efforts to raise the needed money; their operations were suspended and my connection with them ceased just at the time when plans were completed—even to working drawings. I have been much pleased to learn, within the last few days, that far from being discouraged, they are now confidently hoping that they may push on, in the near future, the great work to which they have laid their hands.

Unfamiliar as is the project, you will perhaps be the more ready to share the confidence of its promoters, on hearing the words from Prof. Henry A. Rowland and Dr. Louis Duncan, of Johns Hopkins, to whom were submitted, last spring, full details of the plans partially described in this paper, after reviewing the figures for power required. They say:

"We believe from the data obtained that the values given are not too low, and that the horse power which Mr. Crosby calculates is *not less than the amount required*. While we have investigated carefully and considered all the data obtainable, yet the existing experiments are not sufficient to accurately fix a limit to the train resistance. *We believe, however, that the value assumed by Mr. Crosby is safe.*"

"The motors, the calculations and drawings for which are in the appended statement, will develop the horse power for which they are designed, namely, 500 horse power. We point out some modifications which will be beneficial. *We believe that they will drive the train* (locomotive and two cars, O. T. C.) *at the required speed.*" (Italics here and elsewhere are mine; speed then considered, 120 miles on a level. O. T. C.)

"The possibility of a train being derailed by an obstruction on the track increases with the speed. At speeds up to 90 miles, however, there seems no increase in the number of derailments. In the case in question, the centre of gravity of the cars is very low, and *it would be difficult to derail them on straight parts of the track*. The radius of the curves should of course be great, but not so great as would be required for an ordinary train going at these high speeds. *The question of safety is*, however, *almost wholly a question of track construction.* Considering the form of the proposed train, its comparatively light weight, making a less demand on the track, it is certain that, with a carefully constructed road, it could attain, with safety, speeds which would be impossible with trains as at present constructed. As these latter have several times made 86 miles, and often made 80 miles, *it would seem that a speed of* 120 *miles or even more, with the electric cars, would not be outside the limits of safety.*"

"The plan for supplying current to the motors is feasible."

"The design of the motors is discussed in the detailed report. It is generally good."

"Should it be demonstrated by an actual test that passenger trains can be run safely and economically at a speed over 100 miles per hour from here to Chicago, the financial aspects of the case would certainly be improved. *We are of the opinion that the chances are in favor of this being accomplished by the present scheme.*"

These words, though guarded and accompanied by criticism of the detail, are yet a substantial approval of what was submitted. To me, they were very encouraging.

THE TELEPHONIC REPRODUCTION OF SPEECH.[1]

BY E. MERCADIER.

THE principal object of the telephone is the reproduction of speech at a distance with all its component elements; the articulations with their inflections, the vowels and diphthongs with their characteristic accents, timbre with all its delicacy, and the whole reproduction with sufficient intensity. But the transformations of energy, which go to make up telephonic effects, tend to injuriously affect the human voice.

An alteration of timbre, consisting of a disagreeable snuffling, which distorts words, is due to the fundamental note and harmonics of the diaphragm being superimposed upon those of the voice, without becoming confounded with them; and producing a disturbance of the electric waves, of the movements of the diaphragm molecules, and, therefore, of the sound waves which reach the ear. If my theory be correct, it is not necessary in order to correct this alteration of timbre, to take a diaphragm the fundamental note of which is superior to the limit of the sounds emitted in articulate speech, that is to say, one whose fundamental note is somewhere about ut_4 for men and ut_5 for women. Then the human voice would not tend to produce the fundamental note and harmonics of the diaphragm, which would no longer coincide with the tones of the human voice. Moreover, in order to produce them it would be necessary (owing to the stiffness of the diaphragm) to employ a mechanical force greater than that which the human voice is capable of exerting when speaking. This has been verified by experiment. I will only cite two extreme cases. A diaphragm of 100mm. diameter and 1mm. thick, or one 30mm. diameter and .1mm. thick. Both satisfy the condition mentioned above, and, fixed to appropriate telephones, neither of them produces a sensible alteration in the timbre of the voice.

The alteration of articulations and vowels consists, on the one hand, of the exaggerated predominance of certain consonants, vowels and syllables, *p, b, r, k, a, o, un, on, ent;* and in the marked weakening of *l, s, c, z, i, e* and *u*. The consequence is, that it is frequently very difficult to understand the words distorted in this way. The alteration is due, in large measure, to the shape and aperture of the buccal cavity, which are different in the pronunciation of the various articulations and vowels mentioned above, and to the resulting energy of the sound waves being much weaker in the second case, than in the first. From this point of view this distortion would seem inevitable, but it is also due in some degree to the correlative production of the harmonics of the diaphragm. In fact, while seeking to remedy this defect, I found that it was markedly diminished by precisely the same method as indicated above, employed to suppress the alteration of timbre, that is to say, by suitably proportioning the thickness and diameter of the diaphragm so that its fundamental note shall be very sharp.

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[1] *Comptes Rendus.*

The line joining the transmitter to the receiver also plays a certain part in this connection, which I hope to examine later on.

The third difficulty is the production of two parasitic resonances. The first of these is only noticeable to trained ears, and consists of a metallic crackling, apparently due to a kind of friction along the radii of the diaphragms caused by a change in the direction of the lines of force. This disappears in a diaphragm of high fundamental note. The other effect is the resonance due to the mass of air in the telephone box itself, and may be eliminated by decreasing the air space, by filling the box with felt. At the same time that we obtain clearness in the reproduction of speech, we satisfy the conditions necessary to obtain sufficient loudness, a very fortunate circumstance, since the two desiderata of clearness and loudness are equally indispensable. This fact thus permits us to approximate perfection in an instrument, as delicate as it is marvelous.

THE TELEPHONIC SITUATION IN ENGLAND.

A LARGE number of the National Telephone Company's shareholders met specially a few days ago, writes our London correspondent, to consider the position of the company, now that the first master patent had expired. Many were disposed to look upon the future with misgiving when the right of monopoly was taken away, but before the crowded assembly dispersed it had caught the enthusiastic spirit of the president. The statement as to the business done and the proposed new capital, impressed shareholders favorably as to the future progress. The accounts were so good that they eclipsed all former records of profits. The chairman then spoke of the lowering of rates in the country from £15 to £10, and thought the large influx of new subscribers would more than compensate for the loss incurred. In proof of this, it was stated that during the last half year 1.940 were wired up, giving an average of 74 per week; since the decrease in rates 651 new customers were wired in the first three weeks of this year.

No one can doubt the strong position held by this concern, for it starts in the competition with the advantage of having connections all over England, and no less than 244 towns linked together. It would necessitate an enormous outlay before any other scheme could approach this state, and were the company only likely to be disturbed by private individuals, it would suffer little. It is not, however, new enterprise which will cause a panic, it is the taking over by the post-office of the telephones, a fact which seems to be altogether ignored by the officials of the National Company. For, although the postmaster-general cannot stir in the matter for five years, I imagine, in the event of the company applying to Parliament for statutory powers, which is spoken about, the post-office will make its power felt.

THE ELMORE COPPER DEPOSITING PROCESS.

THE Elmore Copper Company issued invitations recently to members of the press to view the working of the special process at Leeds. In response a large number journeyed down to Yorkshire, including the London correspondent of THE ELECTRICAL ENGINEER.

The works consist of a melting shed where rough Chili bars are melted and converted into convenient form for introduction into the depositing tanks; dynamo room, where are three Mather & Platt's dynamos and Williams and Robinson's engines; depositing tanks; machine hop, where the process of removing the copper tubes from the mandrels is operated; and the testing room.

The following is a rough sketch of the process: Rough Chili bars, containing ninety-seven per cent. of copper, are melted in a furnace and then ladled out and dropped into a tank of water, the copper being afterwards taken out in the form of large granules technically termed "shot copper." These are taken into the depositing room and packed on perforated copper plates at the bottom of each of the sixty tanks to the depth of some inches, so forming the anode. The tanks or baths are about twelve feet and twenty inches, by three feet, six inches, and contain one, two, or three iron mandrels, ten feet, six inches long, and varying from four to eighteen inches in diameter. The tanks are connected in series; about forty were working during the visit. The mandrels revolve in the tanks by means of chain gearing connected at one end of each bath, each set being actuated by pulleys attached to a long line of countershafting running the length of the tanks. It will be seen by this that the deposition on the mandrel takes place from underneath and the circuit is completed by brushes similar to those used for dynamos rubbing on one end of each mandrel. The burnisher, an agate rubbing over about one-half an inch length of surface, moves slowly from end to end of the mandrel, each point of copper surface thus receiving a rubbing under slight pressure about every forty minutes. The current used was said tobe 750 amperes, and the E. M. F. at each tank terminal about .9 volt. Each mandrel has to be first coated with a film of copper in a cyanide bath before it is introduced into the tank, for the purpose of forming a tube upon it, and after the proper thickness has been obtained there is the process of removing the tube, and recoppering the mandrel. The removal is effected by letting the mandrel with its copper deposit revolve, while a machine having a couple of rollers running at right angles to the tube above and beneath it, passes slowly along its length and loosens the copper from the iron; it is then taken to another machine and the tube pulled off the mandrel.

The single plant in operation is stated to be capable of yielding a deposit of some five tons per week of 168 hours. A specimen of copper cut circumferentially gave an elongation of twenty-one per cent., the breaking strain representing twenty-one tons on the square inch.

Literature.

Dynamos and Electric Motors; All About Them. By Edward Trevert, 1891. *Bubier Publishing Company,* Lynn, Mass. Flexible cover, 5x7 inches, 96 pages. Price, 50 cents.

In this little work the author has attempted to give the reader a practical idea of what modern dynamo electric machinery consists of, and has adopted the very excellent plan of carrying this out by means of a detailed description of the manner in which dynamos and motors are constructed, giving full detail drawings and dimensions so that the reader is thereby enabled to construct such a machine for himself. This is followed by an explanation of the methods of construction of an electric battery for running electric motors. The little work contains many practical hints and will no doubt interest a large class, among those who take pleasure in constructing their own experimental apparatus. Mr. Trevert is doing good work in an unpretentious but effective manner.

Bibliotheca Polytechnica; Directory of Technical Literature. By FRITZ VON SZCZEPANSKI. New York, 1890. The International News Co.

THIS is a classified catalogue of books, annuals and journals, published in America, England, France and Germany, relating to legislation, hygiene, and daily life. As it was originally published in German, the alphabetical classification is arranged with reference to that language; so that an English or French reader is confronted with some difficulties. Although the book has evidently been compiled with care, there are many omissions, and the work has, we fear, fallen short of the excellent intention of the compiler.

May's Popular Instructor, for the Management of Electric Lighting Plants. By OSCAR MAY, PH.D.; Frankfort o. M. Shirmer and Mahlau; London, *The Electrician.*

THIS little book is intended to supply the owner of an electric lighting plant with a set of printed instructions, enabling him to check his engineer; and also to assist the engineer in the performance of his duties. The subject is treated so popularly that it may be fully grasped by any one not possessing technical knowledge. In addition to the instructions, which are very complete, there are extracts from the Phœnix Fire Office rules.

Letters to the Editor.

THE ADOLESCENCE OF ELECTRICITY.

Apropos of Prof. Sweet's communication giving a remarkable quotation from some old book about electricity and your editorial remark thereon, I may recall that in a paper which I read in 1884 before the Conference of Electricians at Philadelphia, a quotation was given from a book entitled "An Essay on Electricity," by George Adams, published in London, 1792, which reads:—"As electricity is in its infancy when considered as a science, its definitions and axioms cannot be stated with geometric accuracy."

In this, therefore, you will see not only expressed the hopeful spirit which is manifested concerning the science at the present day, but also expressed in the same words that the electrical Saul among the prophets still uses when he feels moved to say something about it. It was all right then, but it is effete now; it may still be "youth," certainly not "infancy."

THOS. D. LOCKWOOD.

BOSTON, March 5, 1891.

European Correspondence.

LONDON.

Interesting Installation.—Electricity in the Holy Land.—Lighting of Durham Cathedral.—Electric Lighting of the City of London.

AN interesting installation has been erected at a saw mill at Neuss by the Deutsche Elektricitat Gesells. of Aix-la-Chapelle. The motor is one of 20 h. p., which serves to haul logs of wood up to the works from the neighboring Erft canal; the dynamo supplying current to the motor is also used for lighting the premises.

A decided sensation has been caused in Jerusalem by the introduction of the electric light into a flour mill, nigh unto Damascus Gate. It need hardly be said that the Arabs and Jews are much puzzled to account for a light in a lamp in which there is no oil, and up to the present time while gazing with wonder have been keeping at a respectful distance.

I mentioned in a previous communication the probability of using electricity for lighting Durham Cathedral. This project has come to a head, and successful experiments have been carried out to determine the exact lighting power required.

The first practical costructive step towards lighting the city of London by means of electricity was taken a few days ago, when the lord mayor placed in position the first stone of the main junction box for the electric conductors at the top of Wallbrook, close under the shadow of the western walls of the Mansion House. The partial lighting of the city by electricity took place some ten years since, but the imperfections which developed in the earlier systems of illumination operated to prevent any further steps being then taken to extend it, although a sum of £12,000 was spent. About eight years since negotiations were set on foot by the commissioners of sewers with a view to introduce the electric light in its most improved form into the city on a thoroughly practical and commercial basis. The result has been the division of the City into three sections. The eastern division comprises the whole of the city east of the Mansion House, the central division is that between the Mansion House and St. Paul's Cathedral. The third and western division comprises the remainder of the City west of the Mansion House as far as Temple Bar. The central and western divisions have been handed over under contract to the Brush Electrical Engineering Company; the eastern division will be lighted also under contract by the Laing, Wharton & Down Construction Syndicate. The contracts made by the commissioners of sewers provide for the lighting of the whole of the streets of the City of London, partly by arc lamps and partly by glow lamps. The contractors for the central and eastern divisions have obtained powers for supply of electricity to private consumers; and in the western division similar powers are being applied for. The contractors will light every street, lane, court and alley and will obtain what practically amounts to a monopoly in private supply.

According to the scheme, the streets will be lighted in all by 400 arc lamps of 2,000 nominal candle power and 1,000 glow lamps of varying candle power. It is estimated that the cost to the City when the work is fully completed will not very much exceed £20,000 per annum; of this sum the commissioners anticipate that about twenty times the illuminating power at present obtained from gas will be secured. The contracts require that the works for public lighting shall be commenced before the 19th inst., and this ceremony consisted in starting the underground works. This commencement comprises the main junction box, which will be employed for connecting the mains of the two contractors. The object here is to make the systems inter-dependent, so that in the event of a serious breakdown occurring at either of the generating stations, the electric current will be obtainable from the other station.

The sites of the stations have been fixed on the side of the Thames, having a combined capacity of 1,200 2,000 c. p. arc lamps and 120,000 incandescent lamps of 60 watts.

H. S.

LONDON, Feb. 4, '91.

Electric Lighting in the City.—The Guernsey Electric Railway.

SINCE my last communication the Brush Company and Laing, Wharton & Down Syndicate have agreed to transfer to a new company the contracts for lighting the city of London by electricity. Although obscurity is a characteristic of legal documents, the agreements made between the companies are remarkable for opacity. They are so skillfully or unskillfully worded, so intentionally vague, that none but those actually engaged in the transaction could tell with exactitude the precise gain of the vendors. It is true sums of money, presumably large, are supposed to change hands, and that the purchasers acquire contracts, provisional orders, central stations, etc., but these are so clustered together that it is impossible to arrive at the value placed upon any one item.

An important step is about to be taken by the Guernsey Railway Company, Limited, who have decided to substitute electric tramcars for the present steam cars on their line, which is nearly three miles long. The railway was constructed by the Guernsey Steam Tramway Company in 1879 and worked by them until 1888, when the service was discontinued, owing to the severe competition of the omnibuses. The present company acquired the tramway shortly afterwards, and have since been seeking a cheaper method of traction, which they believe to have found in a direct system of electrical traction. The local government board has given permission for the erection of overhead wires.

H. S.

LONDON, Feb. 11, '91.

Home Correspondence.

BOSTON.

A Victory Over the Snow.—Taxing Corporations for Use of Streets.—Fire Department Report.

DURING the recent severe snow storm in Boston, the electric cars may be said to have won in the battle with the elements. Not a single car was ordered off, but assisted by a number of small electric ploughs and brushes, they managed to keep fair time all through the blinding storm. There has been sufficient experience with snow storms now in Boston to prove that electric car systems can be made to successfully cope with the heaviest storm, and that all that is necessary is good management in the providing adequate ploughs and brushes, and getting them out on the line before the snow has a chance to solidify on the tracks. The fight must be begun with the commencement of the storm and no fear need be entertained about the successful running of the cars. The maxim might well be "Look after your tracks, the current will take care of itself."

It is evident that one of the matters before the legislature that will cause most discussion is the measure relating to the taxing by cities and towns of corporations using the streets and highways. There is a tendency to assess the tax upon the dividends of the corporation, exempting from such tax a certain per cent. of the earnings, which would be equal to a fair rate of interest upon the capital invested. One plan that has been proposed is that when there is a dividend of over 10 per cent. for a street railway corporation the fares shall be reduced accordingly. There is a strong possibility that the poles of the telegraph and telephone companies will be allowed to go free from this tax because of the complications that would almost necessarily result from the interstate connections of these companies. As far as street railways are concerned, it is thought that this proposed tax would diminish dividends, rather than increase the price of fares.

An extract from the report of the commissioners in Boston's Fire Department may be found interesting, as comparing the causes of fires, and showing how few can be attributed to the "deadly" electric light wire. The table showing the different causes of fires and alarms since May 1, 1890, includes 17 accidental automatic, 94 needless, 14 false, 5 out of town fires, 31 bonfires, 10 soot in chimneys, 33 from careless use of lamps, candles, etc., pipe or cigars, smoking, and clothes too near stove, 20 because of defective flues, stovepipe, grate or furnace, 17 electric wires, 13 fireworks, 29 from gas, 13 incendiary and 12 supposed to be, 2,953 from the use of kerosene oil, 15 matches and rats, 39 matches and children and 22 careless use of matches, 27 overheated stoves, furnaces and steampipes, 25 spontaneous combustion, 90 unknown, 42 by sparks. Five alarms were given by mistaking smoke or steam for fire.

The following extract may also be found interesting: "The present plan of running the wires of the various electrical systems through our streets is one of the most formidable of the problems with which the department has to contend, and its complications are constantly increasing. While these systems have become institutions that we cannot spare, a further regulation of them is required in order to secure the greatest good of the greatest number. Electric wires are not only active agents in causing fires, but some of these lines are so thickly run in front of buildings as to render it almost impossible to raise ladders for ventilation, carrying up hose or saving life. It might be a proper question of public policy to inquire whether in many such instances the wires might not be carried over the buildings, instead of alongside, until such time as the city shall get ready to order the wires underground. An essential weakness of the ordinance, creating the office of inspector of wires is, that the fire alarm telegraph has been divorced from the fire department. This act seems not to have been considered in the light of experience. While the present inspector understands the needs of the department and the relations of the fire alarm telegraph to other systems, the future, under the present arrangement, is fraught with menace to the best interests of the city and this department, which is the opinion not only of the fire commissioners, but of the inspector of wires as well."

BOSTON, March 8, 1891.

Society and Club Notes.

NEW YORK ELECTRIC CLUB.

At a regular meeting of The Electric Club, held Thursday evening, February 26th, 1891, it was voted to admit new members during the succeeding three months, upon the payment of one-half the initiation fee. This offers memberships as follows:

Active—$20 Initiation fee, and $40 yearly dues.
Associate—$10 " " $20 "

The object of this change is to rapidly increase the membership of the club, the limit of which has been raised to 1,000.

It is hoped that members will take advantage of this opportunity to bring their friends into the club.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Institute on March 17, at the headquarters, 12 West 31st, Mr. J. J. Carty will read a paper entitled "Inductive Disturbances in Telephone Circuits." This subject is one of the greatest technical and practical importance, and could not be in better hands. Moreover, telephonic topics rarely offer themselves, and the art is not one in which there are to-day many experts familiar with the deeper problems of telephonic research.

Secretary Pope has just issued a title page and an excellent table of contents and index for Vol. VII of the *Transactions*. With this is also given an excellent steel portrait of Mr. Edward Weston, the fourth of the Institute's presidents. In keeping with his practice hitherto, Mr. Pope has begun the new volume of *Transactions* by issuing the parts in cover of a new tint. The double number for January and February contains Mr. Kennelly's admirable paper on "Inductance," Mr. Berliner's interesting description of his gramophone, and the valuable discussion on inductance and its new unit, the "henry."

NEW YORK TELEGRAPH CLUB ELECTION.

At the annual election of the New York Telegraph Club the following officers were elected for the ensuing year: President, E. E. Brannin (re-elected); first vice-president, Richard Kane (re-elected); second vice-president, Thomas J. Dunn; third vice-president, James I. Buxton; recording secretary, J. Clayton Watts; financial secretary, John R. Powers; treasurer, John Brant; librarian, L. E. C. Moore.

Personal.

MR. MYRON D. LAW.

The above-named electrical engineer has just been put in charge of the arc lighting work of the Edison General Electric Co., with headquarters for the present at Schenectady. Mr. Law began his electrical career a long time ago. He became connected with the old Telegraph Supply Co., of Cleveland, in 1877, having previously been engaged in general electrical work, such as it was in those days. He was sent to San Francisco to renovate the electrical work in the Baldwin Hotel, and then took hold of the San Francisco Telegraph Supply Co. About 1877-8 the first 12,000 c. p. Brush machine arrived out on the Coast and was put on exhibition. In the spring of 1878 they received the first four-current, four-light Brush machine, which was put up in the Palace Hotel courtyard. On September 16, 1878, Mr. Law started the first 16-light Brush machine for commercial work, with lamps rented at the modest price of $10 apiece per week, six nights a week, till 12 o'clock only. Soon after this the California Electric Light Co. was organized with a capital stock of $5,000,000. In 1880, after this very successful pioneer work, Mr. Law came East, and was associated with Mr. C. M. Rowley as assistant superintendent of the New England Brush Co. He was then sent to Philadelphia and there acted as the company's agent. In 1881 the Brush Co., of Philadelphia, was organized, and there Mr. Law stayed, through all the company's growth and changes, until 1890. He then accepted an invitation to take charge of the electrical reorganization of the Denver Consolidated Electric Co.'s plant at Denver, Col., and there remained until the present time. Mr. Law has had an experience in arc lighting work that is probably unsurpassed in this country.

ELECTRICITY HEALTHFUL IN ST. PAUL.

In response to a request from the Thomson-Houston Co., the board of health furnished them the information that during the past five years there have been 513 deaths from violence, none of which, however, as either directly or indirectly attributable to electricity.

Appointments, Etc.

Mr. John A. Seely has been appointed by the city council of Wheeling, W. Va., its electrical engineer for the purchase and equipment, &c., of its new municipal lighting plant, on which, it is said, $100,000 may be spent.

Manager Wallace G. Riggs, of the Meriden telephone division, is to be removed to New Haven, where he will be the superintendent of the operating department of that division, having charge of the switch boards, testing of the wires and of the electrical department of the office.

A. W. Ives, manager of the Southern New England Telephone Co. for the Ansonia district, has resigned to go to Boston, where he will pursue studies in electricity.

S. H. Bassett, son of R. M. Bassett, the extensive manufacturer of Birmingham, Conn., has severed his connection with the concern there, and will go into company with Stanley & Hall, manufacturers of electrical supplies in this city.

Mr. W. Hazen, who was for 15 years assistant publisher of *The Evening Post*, of this city, has vacated the business managership of *The Electrical World* after a four months' incumbency.

Mr. J. H. Passmore has resigned his position as inspector for the Edison Co. to accept that of electrician for the Rapid Transit Street Railway Co., of Newark, N. J., for whom he constructed the road on behalf of the Edison Co. The road has started off in admirable running order.

Metal and Supply Market.

IMPORTANT REDUCTION IN THE PRICE OF ALUMINUM.

The change in price list announced for their aluminum by the Pittsburgh Reduction Co., of Pittsburgh, Pa., is worthy of special note, and indicates very significantly the rapidity with which the metal is coming to the front. In writing us about this change, the company say: "The facts in the case are that we have come to the conclusion that in order to develop the larger market which we feel confident will surely open up upon reducing the price of aluminum to $1 per lb., it is best to make this rate for any quantity. At this rate, aluminum, which is nearly four times lighter than nickel or German silver, is a much cheaper metal to use than either of them, and is at such a price that it can be economically used for many purposes, being nearly as cheap as copper."

THE NEW D. E. MERITENS PRIMARY BATTERY.

For the past few days, writes our London correspondent, English and French newspapers have dwelt upon a great discovery of M. de Meritens in the shape of a galvanic battery. The inventor read a paper recently before the Societé Internationale des Electriciens, more or less descriptive of his apparatus, but he succeeded in convincing his hearers, who for the most part were not electricians, that he had solved effectually the great problem of the cheapness of electricity. The figures given during the address were too vague to be serious, and time must elapse before an unprejudiced statement is forthcoming as to the actual value of the battery.

M. de Meritens claims to have succeeded in rendering the galvanic pile absolutely constant as a source of electricity, by employing on the one hand pure zincs, and on the other, as the positive electrode, a plate of carbon perforated and covered on the side facing the zinc, with a sheet of platinized lead, the exciting liquid being water mixed with sulphuric acid. A battery was produced which, being short circuited, gave during an hour ana d half a constant current of 33 amperes. It is impossible to tell what would be the output under normal conditions, or at its maximum power over a given external circuit, or what would be the consumption of zinc and acid per effective horse hour or kilowatt hour. According to M. de Meritens, we should obtain electrical energy and hydrogen, which could be collected and utilized, by the expenditure of pure zinc and sulphuric acid for the formation of sulphate of zinc, the composite electrode of platinized lead and carbon remaining unattacked. The sulphate of zinc would then be treated electrolytically, plates of iron being employed as the anode so as to reduce to a minimum the counter electromotive force of decomposition of the electrolyte. The products of the operation, for which motive power is, of course, employed, would be on the one hand pure zinc, which would serve for the mounting of other elements, and on the other hand, sulphate of iron, the marketable value of which varies with the demand.

The Berlin municipality has lately come to the following decision: That no more concessions will be granted for the construction of high level street electric railways, or for electric tramways requiring overhead conductors.

Reports of Companies.

WESTINGHOUSE INTERESTS.

Mr. George Westinghouse announces a further extension of the time for subscriptions to the preferred stock of the Westinghouse Electric Co. to March 20. Interests on the Switch and Signal Co. bonds will be paid on the presentation of coupons.

STATEMENT OF THE BELL TELEPHONE CO.

The Bell Telephone Co. makes the following statement showing the movement of instruments for the month ended Feb. 20, and two months to date :

Month Feb. 20.	1891.	1890.	Increase.
Shipments	6,072	4,298	1,774
Returned	3,276	2,261	1,015
Net output	2,796	2,037	759
Since Dec. 20.	1890-91.	1889-90.	
Shipments	10,237	7,640	2,597
Returned	6,394	4,502	1,892
Net output	3,843	3,138	705
Instruments in use Feb. 20	485,473	446,879	38,594

STOCKS AND BONDS.

SCRANTON, PA.—Mr. Nicholas Kiefer has secured the charter and franchise of the South Side Electric Light, Heat and Power Co., of Scranton, having bought out the other members. This franchise covers the entire city, of which only the centre is now supplied with electric light, and Mr. Kiefer asserts that there is no better opening in the country for a plant of 5,000 incandescent, and 300 arc lights, and urges capitalists to join him in the undertaking. He will be glad to hear from any one desiring to become interested.

HELENA, MONT.—The Helena Electric Railway Co. has mortgaged its property to the Old Colony Trust Co., of Massachusetts, for $500,000, of which $150,000 is negotiable immediately.

MINNEAPOLIS, MINN.—The Minneapolis Street Railway Co. and the Minneapolis, Lyndale and Minnetonka Railway Co. have issued, jointly and severally, 5 per cent. bonds to the amount of $3,093,000, due Jan. 15, 1919. The subscription list was opened at the office of J. Kennedy, Tod & Co., on March 4. Application will be made to have these bonds listed on the Stock Exchange.

THE LYNN AND BOSTON RAILROAD CO. have received authority to increase their capital stock to $1,000,000, for the purpose among others of further equipping the road with electricity.

NILES, O., has reached her limit in bonded indebtedness ($16,000) and if the question of water works or electric light is decided in the affirmative, a special act of the Legislature will be necessary to grant permission to raise the funds.

HOPE, ARK.—The Town Council has been negotiating a sale of the water and electric plants, which had been constructed at a cost of $15,000, to a stock company, for the alleged purpose of enlarging and improving the same. It is proposed to give the company a thirty-year franchise. The company was to be allowed to charge an average of $10.00 to families. The present cost of operating for all purposes is $3,400 per annum and free water to citizens. Judge Mitchell enjoined the sale, and the mayor and aldermen gave notice of application to dissolve the injunction.

ELECTIONS.

OLD TOWN, ME.—At the annual meeting of the Old Town Electric Co., the following members were elected directors: Arthur S. Palfray, Salem, Mass.; Alphonso A. Wyman, West Acton, Mass.; P. H. Alexander, Ferdinand A. Wyman, Warren S. Hill, Hyde Park, Mass.; N. H. Colton, James H. Burgess, Old Town.

NEWPORT, R. I.—Mr. John P. Sanborn has been elected president of the Edison Illuminating Co. A semi-annual dividend will not be paid. The company has declared but one half-yearly dividend.

DIVIDENDS.

The American Waltham Watch Co. has declared a semi-annual dividend of 4 per cent. payable March 2.

KALAMAZOO, MICH.—The City Electric Light Co. has declared a 5 per cent. dividend on stock taken prior to January 1.

PROPOSED NEW YORK BOARD OF TELEGRAPH COMMISSIONERS.

The establishment of a board of three telegraph commissioners is contemplated in a bill put in by Mr. Stein, of New York. They shall be expert telegraphers and be appointed by the Governor for two, four and six years, respectively. They must examine and license successful applicants for telegraphic work on the State railroads. No road, under the bill, can employ any telegraph operator under eighteen years of age or who has not passed the examination of the board. The annual salary of each commissioner is placed at the handsome sum of $5,000. The annual expenses of the board must not exceed $25,000, and the Comptroller must collect the money from the roads interested.

MR. S. E. BARTON'S CLEVER ADVERTISING SCHEME.

Detective Bedford, of Atlanta, has arrested S. E. Barton, president of the Electric Mutual Insurance Company, and agent of the Royal Insurance Company, of Liverpool, the Germania, of London, and the Pennsylvania, of Philadelphia.

It appears that Mr. Barton, who was on his way to Florida, with Luther Stieringer, the expert, to shoot game, was in Atlanta several days, stopping at the Kimball House, and that while there, he wrote up several insurance policies, in violation, it is claimed, of the State law, which requires all insurance companies, doing business in the State, to deposit $25,000 and to take out a license. The Electric Mutual has been given big advertising all over the country by the Associated Press, and some of Mr. Barton's countless friends in the electrical business, who know how slick and shrewd he is, are admiring him for the manner in which he has thus secured a big, free "ad." The case will be decidedly interesting owing to the prominence of the defendant.

ANTI-TELEPHONE LEGISLATION.

The directors of the Telephone Subscribers' Association of the State of New York, resolved at a recent meeting to commission F. S. Gardner to arrange at Albany for the introduction into the Legislature of last year's telephone bill and to exert every effort to secure the passage of the measure.

THE TELEPHONE IN SWEDEN.

State papers recently published in Sweden show that great progress has been made in telephony. There are now 3,338 wires worked by the government, and the total length, including lines operated by private enterprise, is 46,090 kilometres.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of March 7, 1891, from New York, Boston and Washington ; Pittsburgh, March 6.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80	Edison Gen. Elec. Co	100
American Tele. & Cable	79¼	Edison Gen. Co. Def'd	...
Centl. & So. Amer	145	Consol'd Elec. Lt. Co	....
Mexican	210	Edison Illn'g Co. N. Y.	79
Com. Cable Co	106	U. S. Elec. Lt. Co	30
Postal Tel. Cable	39	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	43¾	Ft. Wayne Co	12⅞
" Pref'd.	25¼	Am. Bell	198¼
" Series C	12¼	Erie	47¼
" " D.	6¼	New England	50
" Int. Co	....	Mexican	.80 cts
Thomson Welding Co	....	Trop. American	..
Thomson Eu. Welding	55	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	160
Ches. & Pot. Telephone	55	Eck. & Sold. Home Elec. Ry.	55
Amer. Graphophone	7	Georgetown & Tenallytown	60

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEB. 24, 1891.

Accumulators :—

Secondary Battery, S. C. C. Currie, 447,279. Filed Nov. 18, 1890.
Electrode comprises an interior support, an exterior woven tube and a porous metallic substance or materials cast within the tube and around the support.

Alarms and Signals :—

Thermostat, A. M. Barron, 446,846. Filed Sept. 19, 1890.
Mechanical details of construction.

Police Signaling Apparatus, B. J. Noyes, 447,058. Filed July 28, 1887.
A system for the joint use of police and fire departments ; adapted for distinguishing between police-signals and fire-alarms. An independent receiving instrument is employed at the central station for the police signals together with means for including it in the line and simultaneously cutting out the police-signal receiver.

Police Signaling Apparatus, B. J. Noyes, 447,059. Filed July 28, 1887.
Designed for transmitting determinate signals—as a box number—special signals—as a wagon call—and variable signals—as the numbers by which the police officers are known.

Municipal Signal Apparatus, B. J. Noyes, 447,060. Filed Sept. 14, 1888.
In addition to apparatus at the sub-stations for transmitting various code-signals to a central station, provides mechanism at the sub-stations for transmitting impulses different from those employed in the code-signals, which shall operate an audible alarm or indicator at the central station, whereby an alarm may be made to respond to some of the signals and not to others.

Municipal Signal Apparatus, B. J. Noyes, 447,061. Filed Sept. 14, 1888.
Adaptation of induced or secondary currents to operate alarms or indicators at a central station.

Signal Box, B. J. Noyes, 447,062. Filed Sept. 11, 1889.
Consists in the combination with a signal-box and a key for operating it adapted to be inserted and withdrawn, of a piece of material arranged to be marked upon or embossed by the key.

Non-interference Fire Alarm Signal-Box, W. H. Kirnan, 447,074. Filed March 1, 1889.
Employs a motor for operating signalling mechanism, a handle for starting the motor, a mechanical disabling device for the starting-handle controlled by armature of electro-magnet, and a resetting device operated by the motor at the conclusion of a signal.

Annunciator and Indicator System, J. E. A. Miller, 447,195. Filed Sept. 5, 1890
Details of construction and circuits for an annunciator and indicator system for hotel use and other similar purposes.

Clocks :—

Independent Electric Clock, W. J. Dudley, 447,105. Filed Oct. 18, 1890.
Relates to clocks of the class in which time is measured by a pendulum or balance, while the hands are moved by an electro magnet which is also employed to impel the pendulum or balance.

Dynamos and Motors :—

Electric Motor, L. Gutmann, 446,864. Filed Sept. 18, 1890.
An alternating, pulsating or intermittent current motor. Invention consists in using such currents in the field magnets, whose several cores are suitably subdivided to prevent heating, creating a magnetic field which by induction acts on one or more close-circuited ring-windings, and generating in a single winding of the armature secondary currents differing in quantity and lag from one another by the external application of one or more short circuiting brushes.

Galvanic and Thermo-Electric Batteries :

Galvanic Battery, M W. Robinson, 417,016 Filed June 6, 1890.
Battery shown has four porous cups containing separate positive elements immersed in a single outer vessel containing one continuous negative element.

Lamps and Appurtenances :—

Socket for Incandescent Electric Lamps, J. M. Orford, 446,995. Filed Nov. 18, 1890.

Relates particularly to the switch for making and breaking circuits.

Regulator for Electric Circuits, T. M. Edwards, 447,177. Filed Nov. 5, 1890.

Relates to employment of a liquid resistance in a regulator applicable especially for controlling the circuits of several sets of electric lights in a theatre or other audience room.

Apparatus for Flashing and Exhausting Incandescent Electric Lamps, W. E. Nickerson & A. Berrenberg, 447,256. Filed June 20, 1890.
Relates to a system of apparatus for exhausting a large number of lamps simultaneously, and consists essentially of means for automatically cutting off the current from the lamp circuit whenever an influx of air occurs either through breakage or through inadvertent manipulation.
Claim follows :
In combination, one or more electric lamps, connected to an exhaust apparatus, a main circuit for flashing the filaments of said lamps, a local circuit including a circuit closing device operative upon an admission of air to the exhaust apparatus, and a cut-out for the main circuit, controlled by said local circuit.

Vacuum-Pump, A. Berrenberg & W. E. Nickerson, 447,273. Filed May 10, 1890.

A mechanical pump applicable to the exhaustion of incandescent lamps.
Claims follow :
1. In the jacketing-spaces of a vacuum-pump, deaerated oil as a sealing medium.
2. In a vacuum-pump the combination of jacketing-spaces sealed with deaerated oil, and an apparatus having passage-connection with said spaces and adapted to deaerate the oil and force it through the jacketing-spaces.

Vacuum-Pump, A. Berrenberg & W. E. Nickerson, 447,274. Filed May 10, 1890.
Claim follows :
The combination, in a vacuum pump, of a piston and cylinder, with a filling of deaerated oil adapted to fill all the space under and about the piston within the cylinder at the completion of the stroke of the piston, and thus completely expel all air.

Vacuum-Pump Connection, A. Berrenberg, 447,275. Filed June 2, 1890.
In connection with a system of vacuum-pipes, combines a socket-piece adapted to receive a key or the socket-end of a fork, and having passage-connections with the vacuum system, with a jacketing-piece having passage-connection with a jacketing-system as described.

Metal Working :

Method of and Apparatus for Electric Welding, H. Lemp & L. M. Schmidt, 446,974 Filed July 23, 1890.
Relates to the welding of longitudinal joints ; particularly applicable to jointing strips, bars &c., side by side.

Electric Welding Apparatus, M. W. Dewey, 447,104. Filed Nov. 1, 1890.
Especially applicable to the heating and welding of curved forms, as rings, hoops, tires, etc.

Miscellaneous :—

Binding-Post, C. A. Lieb, 446,871. Filed Sept. 19, 1890.
Details of design and construction.

Fuse-Block, A. P. Seymour, 446,895. Filed July 26, 1889.
Designed to avoid the loosening of the fuse in its clamps ; provides a spiral take-up spring which allows a number of turns backward of the clamp screw without releasing the grip of the clamp upon the fuse.

Automatic Cut-Out, J. P. Tirrell, 446,902. Filed June 4, 1888.
Designed for automatically cutting out a branch-circuit in case of an accidental ground connection caused by the derangement of the terminal points or otherwise ; especially applicable to electric gas-lighting systems.

Cut-Out, S. D. Field, 446,966. Filed May 28, 1890.
A safety appliance for electric circuits.
Claim 1 follows :
A potential cut-out for electric circuits, consisting of an enclosed fluid conductor, such as mercury, connected to the circuit, a grounded terminal adjacent to such conductor, and an interposed gaseous body of relatively higher conductivity than air.

Electric Time-Lock, M. I. Flowers, 446,967. Filed May 5, 1890.
Consists in combination, with an electric motor, of a time dial, a check bolt, and intermediate connections, by which at a predetermined time the check bolt will be actuated or released to permit the locking mechanism proper to be actuated.

Electro Heating Apparatus, C. E. Carpenter, 447,023. Filed Sept 27, 1890.
Applicable to smoothing irons and similar purposes. Combines with the heated surface-plate and resistance employed, a coating of enamel or its equivalent securing the resistance to, but insulating it from, the heated surface-plate.

Vacuum-Core for Electrical Heating Devices, H. R. Butterfield, 447,127. Filed June 25, 1890.
Adapted to smoothing irons. Inventor makes use of a removable hollow shell, which is exhausted of air and contains the resistance.

Electric Heater, J. I. Ashbaugh, 447,143. Filed March 15, 1890.
Employs a solid central bar or part of clay or its equivalent, a coil or wire closely wrapped about such bar or part, and a heat conducting envelope surrounding the coil, the envelope being a non-conductor of electricity.

Railways and Appliances :—

Electric Railway Signal, E. T. Harvey, 446,917. Filed Nov. 6, 1888.
Adapted to enable the engineer of a train to receive an "O. K." signal at different or predetermined points along the line of a road, the road being divided into sections, each having an independent circuit.

Trolley for Electric Railways, S. H. Short, 446,981. Filed Nov. 12, 1890.
Instead of a somewhat deeply grooved trolley wheel as usually employed, the inventor uses a contact roller with a cylindrical periphery and ears or guards projecting alongside the roller beyond its periphery.

Trolley-Wire Hanger, C. H. Macloskie and W. E. Baker, 446,985. Filed Nov. 18, 1890.
Consists of a hollow conical metal case, open from top to bottom and having an annular rib or flange at or near its larger end. An insulating cone of porcelain or other material is adapted to fit against the interior of the conical metal case.

Cross-Over for Trolley Lines, S. H. Short, 447,208. Filed Oct. 22, 1890.
Relates to means for carrying one trolley line or supply conductor over or across another in such a way as to allow the trolley to pass freely on either line.

Electric Railway System, C. J. Van Depoele, 417,215. Filed March 7, 1889
A converter system of distribution and supply for electric railways enabling the energy to be transmitted from the power station at high potential.
Claim 1 follows :
A system of supplying and distributing currents for electric railways, comprising working conductors along the line of way, a circuit supplying currents of relatively high potential, main tension reducing devices connected with the high tension circuit and continuously supplying currents of lower potential to the working conductors, and auxiliary tension reducing devices distributed along the line of way and provided with automatic means for closing the circuits and rendering the auxiliary converters operative upon a fall of potential in the working circuit.

Current-Controlling Device for Electric-Railway Cars, J. C. Chamberlain 447,230. Filed Sept. 9, 1889.
Current regulating apparatus for storage battery cars.
Claim 1 follows :
The combination, with an electric circuit, of groups of batteries, a motor and a regulator having series of contacts for changing the grouping of said batteries and, co-operating therewith, separate series of contacts adapted to connect said batteries with opposite poles of said motor, all of said contacts being mechanically connected, so as to move together.

Electric-Motor Mechanism, S. E. Mower, 447,255. Filed May 31, 1890.
Applicable to electric railway cars. Consists, in connection with a car axle and a continuously running motor, of speed reducing gears connecting the armature shaft with the axle, one of the gears being loose on the axle, a second set of speed reducing gears connecting the armature shaft with the axle, one gear of the second set being loose on the axle, and a double bevelled cone friction-clutch mechanism secured on the axle intermediate of the loose gears of the speed reducing gears.

Electric Railway, R. M. Hunter, 447,283. Filed Dec. 6, 1890.
Relates to the position of an overhead trolley wire with respect to the tracks at curves. At a curve the inventor places the trolley wire somewhat to one side of the centre of the track and towards the outer rail of the curve with a view of diminishing lateral play of the trolley pole when a car is rounding a curve.

Telegraphs :—

Telegraph Transmitter, S. W. Smith, 447,166. Filed Nov. 13, 1890.
A key-board transmitter for Morse signals.

Telegraph Apparatus, J. A. Parker, 447,198. Filed Feb. 28, 1890.
Improvement in devices of manipulation for the telegraph system known as "Stenograph" for which patents were granted to M. M. Bartholmew, No. 215,559, May 20, 1879, and No. 255,910, April 4, 1882.

Telephones and Apparatus:—

Magneto-Electric Signal Device, N. B. Ginochio, 447,045. Filed May 9, 1890.
A magneto-electric call-box adapted to telephone and telegraph service.

Telephone, E. J. P. Mercadier, 447,194. Filed May 26, 1890.
A telephone having its diaphragm adapted to respond only to a tone of a given pitch, and applicable for use in multiplex and harmonic telegraphy. Inventor calls it a "Monotelephone."

Transmitter Circuit, A. C. White, 447,220. Filed July 24, 1890.
An arrangement of circuits and devices providing for the common use by a number of telephone transmitters of a single battery or source of electricity.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 3, 1891.

Alarms and Signals:

Electrical Annunciator, W. E. Cram, 447,558. Filed May 23, 1890.
An annunciator adapted for hotels or similar uses Designed for the employment of relatively feeble currents and to reduce dimensions and consequent space required.

Electrical Door-Bell Pull, L. W. Cleveland, 447,748. Filed Dec. 1, 1890.
Adapted for increased protection of the contact parts from the action of the weather.

Conductors, Conduits and Insulators:—

Electrical Subway, J. C. Reilly, 447,850. Filed May 20, 1890.
Composed of one or more ducts, within one or more of which is placed a leading-in device consisting of a longitudinally slotted tube fixed to the interior wall of a main duct or passage: within such interior duct is a link composed of a metal plate slightly greater in width than the diameter of the tube so that one edge projects downward through the longitudinal slot; the conductor or cable to be drawn into position is attached to the protruding edge of the link-plate above mentioned.

Distribution:—

Electric-Lighting System, B. B. Ward, 447,482. Filed May 5, 1890.
Consists in an arrangement of circuits and of devices for equalizing the resistances in several multiple-arc branches, as in arc or incandescent lighting.

Electrical Transformer, R. Kennedy, 447,569. Filed Dec. 29, 1886.
The transformer consists of insulated copper conductors for the primary and secondary circuits enclosed throughout their length within an outer sheathing of iron wires or plates, in the form of a cable which may be coiled up or bundled in any convenient manner. Connections may be made by any number of points along the length of the cable for obtaining any desired electromotive force less than the maximum.

Dynamos and Motors:-

Electric Dental Motor, H. H. Blades, 447,291. Filed March 23, 1888.
Relates especially to means for manipulating or regulating the currents of an electric motor by mechanism located at the hand-hold at the end of a flexible shaft such as is usually employed with dental machinery.

Commutator Brush, E. W. Rice, Jr., 447,352. Filed Nov, 28, 1890.
Claim 1 follows:
A carbon commutator-brush having a metal coating gradually decreasing in thickness toward the wearing surface of the brush.

Dynamo-Electric Motor or Generator, E. Thomson, 447,384. Filed Oct. 20, 1890.
Comprises improvements in the means for connecting the armature wires with the commutator segments, and in means for binding together the projecting ends of the armature-windings into a fairly rigid mass with the armature body.

Commutator Brush, W. Main, 447,469. Filed Dec. 23, 1889.
Consists of a series of contact plates arranged to be held in contact with the commutator by centrifugal force when used with a stationary commutator and rotating brush-carrier, or by a spring when the brush-carrier is at rest or moving slowly; brush consists of a series of parallel plates inclined to the surface of the commutator with their edges parallel with the plane of rotation.

Electric Motor, E. B. Meyrowitz & F. Buchhop, 447,734. Filed May 21, 1890.
Relates to portable motors for light work, and consists in design and construction adapted for the enclosure of the motor in a substantially spherical shell or casing.

Lamps and Appurtenances:

Incandescent-Lamp Socket, H. J. Gutman, 447,315. Filed Sept. 29, 1890.
Relates chiefly to the contact points, and is applicable to other purposes as well as to lamp sockets.

Electric-Arc Lamp, E. Thomson, 447,383. Filed Feb. 16, 1884.
Designed mainly to provide for an accurate alignment of the upper and lower carbons, and thus to permit the use of carbons of relatively small diameter.

Universal Joint for Incandescent-Lamp Brackets, E. C. Bennett & E. C. Freeze, 447,486. Filed Apr. 4, 1890.
Enables an incandescent lamp to be adjusted to any position.

Electrode for Electric-Arc Lamps, A. C. Siebold, 447,702. Filed Oct. 30, 1890.
A negative electrode designed to be practically indestructible.
Claim 1 follows:
In an arc lamp, a negative electrode consisting of a metallic bar or rod having a layer of carbon upon one end enclosed or covered by a thin metallic plating.

Electric-Arc Lamp, L. H. Buchanan, 447,746. Filed July 8, 1890.
A lamp of the class employing carbon discs instead of rods or pencils; the discs are in sector form and are placed in a horizontal plane.

Medical and Surgical:—

Rheostat, J. O'Meara, 447,494. Filed Nov. 15, 1890.
A rheostat adapted to the control of currents for electro medical purposes.

Miscellaneous:—

Electric Heater, C. H. Rich, 447,353. Filed Sept. 15, 1890.
Consists of a heat-absorbing core provided with washers of an absorbing and radiating nature and coils of insulated wire about the core and between the washers; the heat is absorbed from the inner part of the coils and brought to the surface for radiation.

Electric Time-Lock, J. H. Kaiser and A. B. Ledwith, 447,409. Filed May 15, 1890.
For safes. Consists in a locking-bolt and means for operating it, an electro-magnetic device co-operating with the clock-movement in operating the bolt, and a device by which the bolt may be operated from the outside of the door.

Electro-Magnetic Cut-Out, G. Taintor, 447,529. Filed Aug. 16, 1890.
A safety device. Designed to ground a line at various points during dangerous disturbances and thus shunt heavy currents away from fuses and instruments; also facilitates the testing of lines.

Electric Cut-Out, G. C. Gammon, 447,676. Filed July 2, 1889.
Adapted to break an electric circuit after a pre-arranged period of time when the same becomes grounded or otherwise closed, thus preventing waste of battery.

Electric Snap-Switch. G. W. Hart, 447,728. Filed Aug. 21, 1890.
Design and construction for simplicity.

Railways and Appliances:—

Electric Railway, W. H. Knight, 447,332. Filed Mar. 18, 1886.
Relates to a conduit system of electric railways and includes a supplementary frame on a car or locomotive for supporting the motor and contact device. The supplementary frame is journaled on the axles, supports the car through intermediate springs, and carries the motor.

Conduit for Underground Trolley Wires, H. J. Medbery, 447,338. Filed Nov. 21, 1890.
Conduit is made of wood pulp or other fibre, and is either moulded into shape under great pressure, or made from sheets which may be bent and fixed into shape under the influence of heat and pressure.

Turn-Out and Crossing for Line Conductors, S. H. Short, 447,496. Filed Apr. 12, 1890.
Particularly designed for roads employing two overhead or underground trolley conductors in a complete metallic circuit.

Trolley for Electric Railways, W. J. Calvert & W. P. Wiswall, 447,632. Filed Aug. 27, 1890
Provides an attachment for the trolley which will clear ice from the conductor, and will also serve as a guard to keep the trolley from leaving the conductor.

Electric Motor, R. W. Traylor, 447,704. Filed May 21, 1890.
A motor especially adapted for electric cars.
Claim 1 follows:
In an electric motor, the combination, with the pole-pieces of the field magnets, of cores arranged between the yokes and the parallel projections of the pole-pieces, each magnet being wound with a separate coil, and a countershaft extending between and parallel with the cores of said magnets.

Telephones and Apparatus:—

Telephone-Switch System, C. C. Gould, 447,426. Filed Oct. 10, 1887.
Designed for use in telephone exchanges and intended to facilitate and expedite manipulation.

Telephone-Exchange Apparatus, F. G. Beach, 447,485. Filed Feb. 4, 1888.
Consists in devices and arrangements of circuit intended to reduce the number of lines required in metallic circuit exchanges by combining as a metallic circuit the lines of any two subscribers conveniently located.

SHEARING SHEEP BY ELECTRICITY.

The suggestion which was made some short time ago that electricity should be utilized for the shearing of sheep, has, it is stated, been promptly taken advantage of by the Australian sheep farmers. A very effective installation has just been made on the Raukapuka estate for actuating Wolseley sheep-shearing machines by motors. Ten of these machines are now electrically worked there, and it is calculated that the extra value of the clip of 13,000 sheep has nearly recouped in one season the whole cost of putting up the machines. In the Raukapuka plant, a turbine drives the dynamo, and an overhead wire conducts the current to the motor which drives the shafting in the woolshed. Special arrangements are made to keep the speed of the shafting constant, though the work being done continually varies. It deserves mention that the idea originated two or three years ago with Mr. George H. Guy, the secretary of the New York Electrical Society.

A NEW SUBWAY SCHEME FOR NEW YORK CITY.

A bill has been introduced in the New York Senate to wipe out the Board of Electrical Control and establish a new Subway Commission, which may spend $3,000,000 of city money on new subways in any year and which would practically come into possession of such subways as now exist under private control.

LIGHTING AN IMPORTANT RAILWAY TUNNEL.

A good deal of satisfaction is expressed by commuters and other travelers on the Delaware, Lackawanna and Western Railroad at the announcement that Samuel Sloan, the president of the company, has decided that the Bergen tunnel shall be lighted by electricity. The work will be carried out by Mr. Paul H. Brangs, the electrician of the Railway Co., who is already taking steps to carry out Mr. Sloan's ideas.

A COLOMBIAN CABLE.

An important contract has been signed by the Colombian Government for the construction of a sub-fluvial telegraph line from the head of navigation on the Magdalena River to Carthagena and Barranquilla, and a submarine cable from these points to Colon, where connection will be made with the lines already communicating with the United States and Europe. The work is to be completed within two years and a half, and will put Colombia in good telegraphic connection with the rest of the world.

Legal Notes.

THE AMERICAN RAPID TELEGRAPH CO. DEFEATED.

The appeal of the American Rapid Telegraph Company from the judgment of the General Term of the Supreme Court, in favor of the Board of Electrical Control in the suits brought to have the subway acts declared unconstitutional and void, has been decided, by the Court of Appeals, against the company.

AUGUST JOHNSON vs. ERIE TELEPHONE CO.

Suit for $15,000 damages has been brought by Mr. August Johnson, of St. Paul, Minn., against the Erie Telephone Co., for injuries received from being thrown from his buggy. He claims that his horse took fright at a telephone pole which overhung the street.

LOCAL ELECTRIC LIGHTING COMPANIES SUING NEW YORK CITY.

The Brush Electric Illuminating Company and the United States Electric Lighting Company have begun actions against the city for damages to their poles and wires. The former asks for $525,000 and the latter for $550,000. The suits are the outgrowth of the crusade against the poles and overhead wires made by the Commissioner of Public Works under orders from the Mayor in December, 1889, and following months. The poles and wires were removed on the ground that they were a menace to life.

The companies base their claims for damages on the losses they suffered through the interruption to their business caused by the breaking of the electric circuits with which they supplied private patrons. The city's defense will be that it has the right to regulate structures in the public streets affecting the life and health of the general public.

DANGEROUS WIRES AND POLES.

The Hudson County Grand Jurors have sent to Judge Knapp a communication stating that for months past the wires and poles of the Western Union Telegraph Company and of the Bell Telephone Company in many places in the county have been and still are a source of danger and injury to the persons and property of the people. They ask the court to abate the nuisance.

ELECTRIC SIGNAL LITIGATION.

A suit has been brought by the Electric Secret Service Company, of West Virginia, against the Gill-Alexander Electric Manufacturing Company, of Kansas City, Mo. The invention in dispute is an automatic electric signal, an appliance by which telegraph operators are enabled to signal any specific office without signalling all the other offices along the line. Edwin R. Gill is the inventor. The West Virginia Company allege that they bought the entire patent from Gill, and seeks to enjoin the Kansas City Company from manufacturing the article. Gill says that he sold the West Virginia company only a half ownership in the patent.

A TROLLEY WIRE INJUNCTION DENIED.

In the proceedings brought by John W. Decker and others, property-owners along the line of the Harlem Bridge, Morrisania and Fordham Railway Company, to prevent that company from adopting the trolley system of electrical transportation, on the ground that their consent was obtained by fraudulent representations, Judge Ingraham has refused to grant the injunction.

ANOTHER WESTERN UNION POLE INJUNCTION.—Upon the application of M. H. Oppenheim, counsel for William Meles, who resides at No. 146 West Seventy-first street, Judge Ingraham of the Supreme Court has granted a temporary injunction, restraining the Western Union Telegraph Company and the Fire Commissioners, from maintaining an unsafe pole in front of his residence, and from erecting or maintaining poles and wires on Seventy-first street, between Columbus and Amsterdam avenues. This is the third proceeding which has been instituted against the maintenance of poles and wires in that section of the city, and the tirade against such obstructions is gaining impetus.

UNIONTOWN, PA.—The injunction asked for by the Pennsylvania Railroad Company to restrain the Uniontown Electric Street Railway Company from running any cars, has been refused.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Dividends from advertising depend on the care and shrewdness with which the money is invested by the advertiser."

ELECTRIC MOTORS WITHOUT COMMUTATORS.

The Elektron Mfg. Co., of 79-81 Washington street, Brooklyn, has just issued a neat little brochure under the above title, and containing a great many testimonials as to the value and usefulness of their motors. It has the following pithy little preface:

It is well known that the average electric motor requires less attention and less skill to operate than any other machine from which power is obtained; and that people who have bought a good machine and are careful to give it a few minutes' attention daily according to instructions, have invariably found it satisfactory.

If everyone in charge of a motor was careful to give it a fair show this little brochure would never have been written, but what manufacturer has not had occasional experiences with people too careless to follow simple directions, or to prevent ignorant persons and small boys from meddling with the brushes and switches, yet who become dissatisfied with the resultant annoyances and condemn a machine that in other hands would have been a perfect success.

Nothing short of a machine that will take care of itself under all possible conditions will give such people entire satisfaction. Is it possible to make one?

Ever since the advent of electric power inventors have been working in this line. They have usually sought to abolish the commutator and brushes as being the parts requiring the most attention and most likely to be disarranged through accident or ignorance, but so far their efforts appear to have been unsuccessful, and it is more than probable that the commutator will always remain an essential part of both motors and dynamos where continuous currents are used.

Instead of attempting to do away with commutators and brushes we have attempted, and by correct design, self-adjusting brushes, self-oiling bearings, and a great reduction in speed have succeeded in entirely avoiding all the annoyances referred to. The motors run practically without attention and there can be no "monkeying" with the brushes. Patents have been granted to us for important features of the improvements.

The Perret motor has heretofore ranked with the best. With these improvements it stands unequaled.

The first motors equipped with the improvements mentioned have been in use nearly a year and have given unqualified satisfaction.

RAW HIDE PINIONS AT THE MORGAN ENGINEERING WORKS.

The New Process Raw Hide Co., of Syracuse, have received the following from the Morgan Engineering Works, of Alliance, O.:

"On Dec. 6th, 1890, you wrote inquiring whether the raw hide gears gave us satisfaction in regard to wear and noiseless feature and the need of no oil. The eight pinions were used on four motors, two 15 and two 20 horse power for operating two 25 ton cranes, for handling locomotives for the Pennsylvania R. R. Co. at Altoona, Pa. We must say they have given us the highest satisfaction and we have no complaint whatever to make.

"We have replaced on a large 10 ft. planer, steel bevel wheels with raw hide gears, and they have now been running over a year and a half, giving entire satisfaction and outwearing both bronze and steel.

"The reason we did not answer your letter previously, is that we desired a longer time to test these gears before giving you our opinion."

THE INTERIOR CONDUIT AND INSULATION CO.

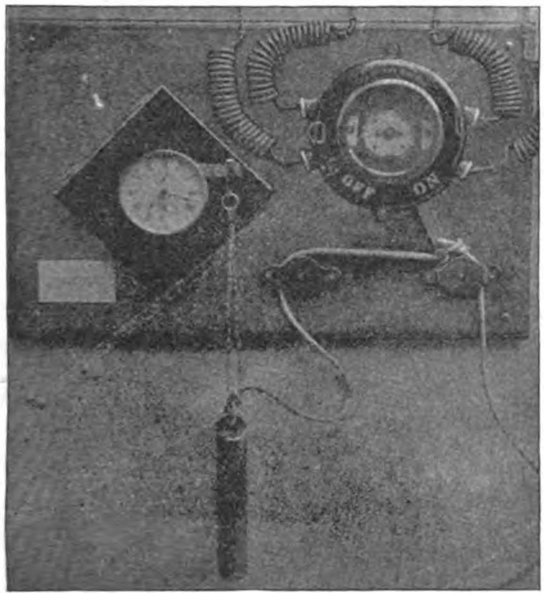
In THE ELECTRICAL ENGINEER of June 18th, 1890, appeared a full description of the methods employed by this company, which had at that time just issued its prospectus. It has now been found necessary, in view of the rapidly growing demand for the system, to open a branch office in Chicago. The unprecedented success of the company proves that the trend of popular opinion toward better and safer wiring is assuming the nature of a demand.

GIBSON UNINTIMIDATED.

The Gibson Gas Fixture Works, 1,426 Callowhill street, Philadelphia, have issued the following defiance, under date of March 5: "We will indemnify purchasers of our electric or combination fixtures against all infringement suits. The Trust threat is simply another desperate attempt to intimidate dealers."

THE AUTOMATIC CLOCK FOR LIGHTING CIRCUITS.

Some time ago, The Electrical Engineer described the automatic clock of the Electrical Engineering and Supply Co., of Syracuse, N. Y., for cutting out incandescent or arc lamps. The accompanying illustration shows the clock attached to an arc switch, as exhibited at the Providence Convention, where it attracted considerable notice. To set the clock, the sliding bar at the right is drawn out until it rests against the inclined track; the traveler is hung on the track, and, at the time set, the traveler rolls off, falling with sufficient force to throw any style of switch, and cut out the lamps. The clock is especially useful for cutting out loops at any hour, on all night circuits, thus avoiding the necessity of a patrolman to switch out lights.



The Automatic Switch Clock.

FEED WATER HEATERS IN ELECTRIC LIGHT PLANTS.

Mr. H. S. Cooper, the superintendent of the Conshohocken Electric Light and Power Co., has recently addressed the following very interesting statement to Warren Webster & Co., of Philadelphia, dealing with the question of feed water heating and steam economization:

In reply to yours inquiring as to the action of the "Vacuum" exhaust economizer and feed water heater, we would say that after three months' steady use, we are more than satisfied with it, as our acceptance of and settlement for it would prove.

Our feed-water is phenomenally rich in the sulphates and carbonates of lime and magnesia, in fact it is a veritable mineral water, and with our previous heater, gave us great trouble, clogging the heater and fouling the boiler, and as the heater was a tubular one, it was next to impossible to clean it of the adhering scale, and in consequence we could only get from 135° to 140° temperature of feed-water. Since using the economizer we have no trouble with scale in our boilers, in fact the old scale is gradually coming off. The annual inspection of our boilers was made last week by the insurance company, and they were pronounced in much better condition in regard to scale than a year ago, when using same water and the tubular heater. The deposit of lime, etc., in the economizer is so heavy that we are compelled to clean it every two weeks, and with the extra set of deposit plates you sent us we can do it *easily* in less than an hour and with the engines running, if necessary. With our old heater, all this or *nearly* all this deposit was in the *boiler*, and what *did* deposit in the heater we were unable to get out and it stayed there, preventing a thorough heating of the feed-water. With the economizer we find only a difference of 1° or 2° before and after cleaning it, we get a steady temperature of 210° *at the pump* when using the most water, and when using only a small quantity have found it as high as 211° at the pump, which would show *very* close to 212° in the economizer, and that with a perfectly free exhaust, or rather with a slight vacuum, as the difference in our exhaust is noticeable when we use the economizer and when we do not.

As you know, we were prejudiced against the "open" form of heater, owing to our fear that the oil in the exhaust steam would be carried back to the boiler in the feed-water. After a very close examination, we cannot find *any* trace of oil in our boilers, your arrangements in the economizer entirely clearing the water of the oil. We are also well pleased with the automatic feed and discharge valves on it; they give us no trouble, we turn the economizer on when we start and hardly look at it until we stop. In fact, for efficiency, simplicity, compactness and accessibility for cleaning, it is without a rival.

The writer has used or had in service *all* of the leading exhaust heaters on the market, and while many of them are excellent, there is not *one* good point in any of them that your economizer does not cover, and there are many points in the economizer that *none* of them have.

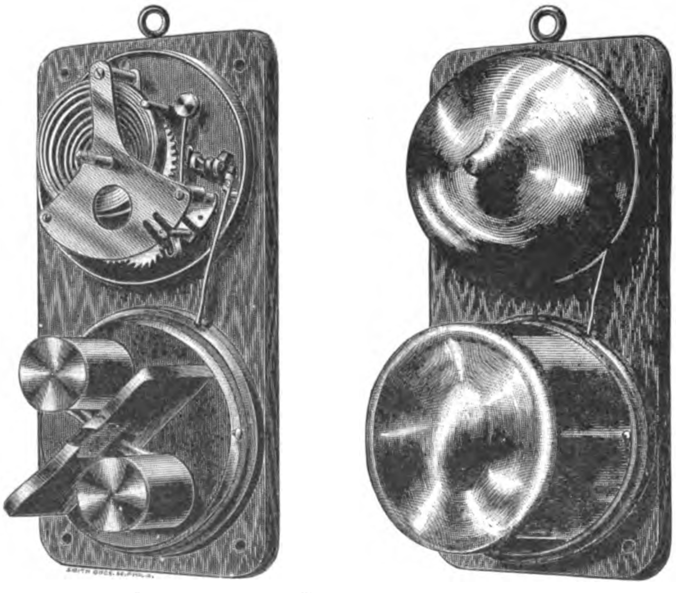
We shall be pleased to show ours to anyone at any time, or to take them to see any of the others you sold around here, and they all appear as to be as well pleased with theirs as we are with ours.

Of course, with a freer exhaust, and with hotter and cleaner feed-water, we are saving coal right along, a very nice interest on the money paid for the economizer, to say nothing of cleaner boilers.

A NOVEL FIRE AND HEAT ALARM.

The accompanying illustrations show the Iske automatic fire alarm, manufactured by Stoner, Myers, & Co., of Lancaster, Pa. Fig. 1 shows the device with the gong and case removed, the clock work, and means of starting it being visible; while Fig. 2 shows it as it appears hanging on the wall ready for use. The operation is as follows: The two cylinders shown at the bottom in Fig. 1, are connected by a tube which extends nearly to the bottom of the lower cylinder. This cylinder is partly filled with some liquid which will volatilize readily when relieved of pressure, and the whole (cylinders and tube) is exhausted of air, and hermetically sealed. It is then pivoted at some point on the tube so that the lower cylinder will just overbalance the upper, as shown. When, however, heat is applied, part of the liquid speedily evaporates, the pressure of the vapor forcing part of the remainder through the tube, into the upper cylinder, when it immediately overbalances the lower, and both rotate about the pivot. Their rotation is sufficient to set in motion the clockwork, and start the bell ringing.

The device can, of course, be adapted to electric bells equally well, but where it is not desired to sound an alarm at a distance, the clockwork is held preferable, on account of its simplicity, cheapness and portability. The clockwork is entirely encased by the gong, and is wound by means of it, so that no key is required.



Figs. 1 and 2.—The Iske Fire Alarm.

The alarms, unless specially ordered, are made to sound at 110° Fahrenheit. The apparatus is handled in this city by Frederick Pearce, 79 John street, this city.

THOMSON-HOUSTON PLANTS IN THE WEST.

The Western Isolated Lighting Department of the Thomson-Houston Electric Co., Chicago, report the following recent sales:— Calumet Distilling Co., New Chicago, Ill., 200 light incandescent plant (increase). Bradner, Smith & Co., Chicago, 20 light arc plant (increase). Woodcock & Loring, Clifton House, Chicago, 12 arc light plant; Liss & Rickeman, 75 North Clark Street, Chicago, 120 light incandescent plant; D. B. Fisk & Co., Wabash avenue and Washington street, Chicago, 35 arc plant and 250 incandescent lights,

PATENT METALLIC SHIELDED AND ANTI-INDUCTION WIRE.

Since the general growth of the electric light and railway circuits, telephone service has been more or less hampered by its great enemy, induction. Many attempts, more or less successful, have been tried to overcome this difficulty, and many so-called anti-induction wires have been invented. We illustrate in the accompanying engravings two forms of wire, manufactured under the patents of Henry F. Campbell, of Boston, which are well calculated to overcome induction and to be of valuable service to telephone and telegraph companies, who are willing to pay for first-class installation work. For telephone purposes, as shown in Fig. 1, this wire consists of an ordinary No. 12 galvanized iron wire, insulated either with rubber and saturated braid or with two or three saturated braids, and then spirally wound with a metallic shield consisting of a strip of annealed iron ribbon, and the whole covered over with a strong braiding. But Fig. 2 shows another form of the wire, with a copper shield instead of the iron, which can be supplied if desired. When used for telephone service as a metallic circuit, these wires have shown remarkably good results, and they are attracting a great deal of attention. The metallic shield also acts as a very excellent resistance to abrasion from the limbs of trees or other obstacles, and prevents in a large measure any danger of both sides of the circuit being grounded. The two circuits being in one composite wire, it will also be seen that it effects a great saving in cross arms, insulators and general pole construction. This wire is also manufactured for aerial electric light line wire, the shield in this case acting as a good preventive from abrasion and protecting intact the underlying insulation much better than any cotton or yarn braiding could do. The wire is manufactured by the National Electric Company, of 19 Congress street, Boston, with Mr. Charles E. Jackson, president, and N. T. Greenwood, treasurer, and they have a well equipped factory at 22 Medford street, Boston. Great care is taken with the manufacture of the wire, any desired degree of insulation being attainable, and every reel is thoroughly tested in tanks with delicate galvanometers before shipping.

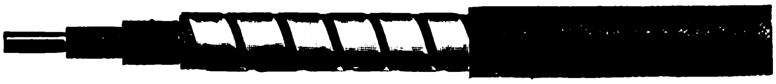


Fig. 1.—Metallic Shielded Anti-Induction Cable.

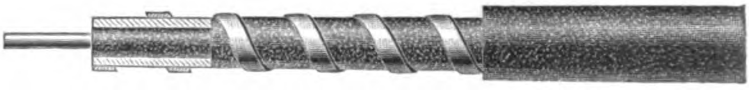
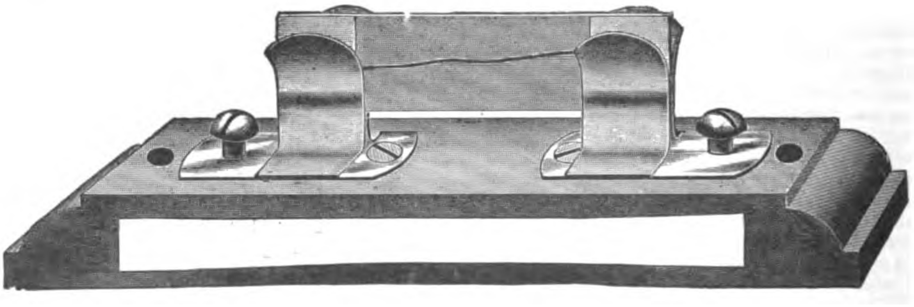


Fig. 2.—Metallic Shielded Anti-Induction Cable.

A NEW FUSIBLE STRIP AND HOLDER.

The accompanying illustration shows a convenient form of fusible strip and holder especially designed to protect telegraph, telephone and other instruments from damage by lightning, or heavy dynamic currents. By a new process, the fuse wire is adjusted to blow with any desired current, that in the drawing being for a current of one-half ampere. When a fuse blows, the strip can be removed and a new one substituted with the greatest facility, the inspector carrying a few extra strips in his pocket to replace those destroyed.



The Central Electric Company's Fusible Strip and Holder.

The device is controlled and sold by the Central Electric Company, of Chicago.

Mr. John H. Bowley, formerly assistant to Prof. Morse, and who assisted at the laying of the first Atlantic cable from the American man-of-war "Niagara," died on Sunday, March 1st, at Jersey City.

CAPITAL OFFERED FOR INCANDESCENT LAMP WORKS.

An advertisement appears in our columns this week from a gentleman who represents capitalists desiring to invest in the manufacture of incandescent lamps, and who are ready to put capital in an established business or to start a new concern. The proposition is in every respect one that deserves consideration.

AN INTERESTING LITERARY RELIC.

Mr. G. W. Davenport, the vice-president of the Thomson-Houston International Co., secured recently while in Europe a most interesting relic of which he is very justly proud. It is none other than Michael Faraday's own copy of Franklin's well-known and rare collection of letters and papers on philosophical subjects. It has his book plate on the inside of the front cover, and bears signs of use.

As touching on a late memorable controversy, Mr. Davenport points out that on page 325 Franklin remarks that "Death by electricity would be the easiest of all deaths." It is a little strange that electrocutionists have not hit on this and used it.

THE COLUMBIA SNOW SWEEPER.

In our issue of Feb. 4, we published an illustrated article on the excellent "Columbia" snow sweeper, recently brought out by the Columbia Electric Co., manufacturers of dynamos, motors, &c., St. Paul, Minn. It should be added to the description then given that the car itself was the design of Mr. George Larkin, the chief engineer of the St. Paul City Railway Co., the motors being the design of the Columbia Co., as already stated.

PAISTE ELECTRICAL SPECIALTIES.

A very neat and tastefully printed little catalogue, entitled, "Some Practical Pointers," has been issued by H. T. Paiste, of Philadelphia. The "pointers" refer to several of his specialties, such as switches, cut-outs, sockets, shade holders, etc., all of which are so well known that nothing remains to be said in regard to them, except that they are still enjoying a well earned popularity.

A LARGE CARD ARC MOTOR.

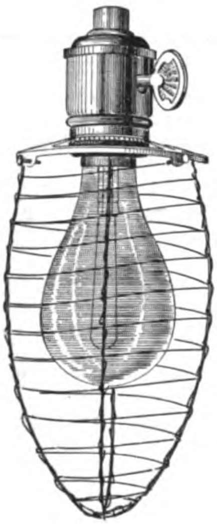
The Card Electric Motor & Dynamo Co., of Cincinnati, have recently shipped one of their new type 6 h. p. arc motors to St. Louis. This machine is probably one of the largest arc motors made.

A NEW DIRECT CABLE OFFICE.

The Direct United States Cable Company has opened a special office at 21½ Spruce street for the purpose of providing a greatly accelerated and more direct service for the numerous patrons of the Atlantic cables in the district familiarly known to New York business men as the "Swamp."

ESTEY'S NEW LAMP GUARD.

Of the many things which recommend the incandescent lamp as an illuminant in theatres, mines, factories, etc., the question of its portability is no small one to consider. But the lamp must be protected, as, should it come in contact with any hard substance, which is liable to happen, it is very easily broken. The accompanying cut shows a wire guard to protect the lamp from this danger. The guard is manufactured by W. S. Estey, 71 Fulton street, this city. This guard is made very strong and fits into any ordinary shade-holder of the necessary diameter.



Estey's New Lamp Guard.

TRANSMISSION ROPE.

The two principal objections to the transmission of power by manilla rope have always been the inability of the rope to stand, for a long time, the effect of moisture, and the internal friction caused by passing over the sheaves.

Both of these faults have been greatly mitigated by the C. W. Hunt Company, of 45 Broadway, in their "Stevedore" transmission rope. This is laid up with tallow and plumbago with the twist of the rope, the tallow making it partially waterproof, and the plumbago acting as a lubricant, and reducing the internal friction. It is claimed to be the only rope that will stand exposure to the weather.

LAVA ELECTRIC INSULATORS.

A substance that is absolutely fire-proof, non-porous, and insoluble, having the rigidity of stone, and the non-conducting properties of dry air, appears certainly to combine in itself every quality desirable in an insulator.

The D. M. Steward Mfg. Company, of Chattanooga, Tenn., seem to have produced such a substance in their lava insulator, which is claimed to possess greater possibilities, and a wider range of application, than any other substance ever used for the purpose. It is equally effective for inside or outside use, underground or in damp places; it can be cut, turned, or molded into any shape required, before being hardened, and the process of hardening does not warp the pieces. Hence it may be made to fit any given place as accurately as brass, often a great desideratum to electricians. No heat, short of the electric arc, has any effect upon it, and, as it is perfectly non-absorbent, it can be used with no fear of damage in cellars, steamy rooms, or where exposed to the fumes of acids, etc.

Holtzer-Cabot Electric Co.—All the right, title and interest of Charles S. Bush Company, and Charles S. Bush, in and to the Providence Construction Co., and its assets, have been sold to the Holtzer-Cabot Electric Co., of Boston, Mass., and all parties are notified that Charles S. Bush Company and Charles S. Bush, will not be liable for any debts contracted by said Providence Construction Company, hereafter. All debts and claims against said Providence Construction Company, may be rendered to the Holtzer-Cabot Electric Company, and will be promptly paid.

WOODBRIDGE & TURNER.

The above enterprising young firm of electrical engineers and street railway contractors have found it necessary to secure larger offices, and have removed to Room 47, the *Times* building, where they will enjoy greater facilities for their growing business.

THE GAYNOR ELECTRIC CO.

A very handsome new factory has been built by the Gaynor Electric Co., of Louisville, Ky. It is of brick 224 feet long, 60 feet wide, and six stories in height. Power is supplied by a 250 h. p. Corliss engine. The company's capacity is increased fourfold, and it is claimed that they will have the largest factory in the world devoted to fire alarm and police signal apparatus.

The company's systems of fire alarm and police signaling are well known and in constant demand. They are now carrying out contracts for San Antonio, Tex.; Lincoln, Neb.; Clinton, Ia., and Louisville, Ky.

THE RAE ELECTRIC RAILWAY SYSTEM.

A very interesting pamphlet has been published by the Detroit Electrical Works on the Rae Electric Railway system which it is introducing with such phenomenal success and rapidity. There is given a very complete description of the system as a whole, and in detail, interspersed with large explanatory cuts; and this part is admirably clear. There is also a neat classification of the various electrical, machanical and economical advantages of using the Rae system. The frontispiece is a fine view of the Detroit Electrical Works on Baltimore and Woodward avenues, Detroit, and the whole is bound up in a handsome cover.

A WORD TO THE WISE STEAM ENGINEER.

A few years ago, says the *Stationary Engineer*, no one dreamed that in so short a time the electric light would become a regular part of the equipment of mills and factories. It was only when the dynamo found its place in the engine room and the incandescent light sparkled in the shops and work rooms that the engineer found anything of special interest to him in the study of electricity. Now he must study it whether he will or no, and though the knowledge he most requires must be of a practical nature, he must have a goodly amount of theoretical or "book" information in order to understand what he is doing.

ST. LOUIS TRADE NOTES.

The East St. Louis Electric Railway is now in successful operation. Thomson-Houston system is used. Eight cars are in use running from the Levee to the National stock yards.

The Columbia Incandescent Lamp Co., having increased their capital stock, have put in new machinery and pumps, increasing their capacity to double their former output. They are now prepared to supply their many customers without delay. Mr. Leonard Schaefer, formerly with the Schaefer Electric Lamp Co., of Cambridgeport, Mass., and the Sawyer-Man Electric Co., has been engaged as superintendent.

The Emerson Electric Manufacturing Co. have brought out a new cross-over for trolley wires, the novel feature of which is that a trolley wheel of any pattern can pass it without flashing. This company are meeting with an excellent trade in all of their late novelties, notably the Bagnall trolley crossing and their spring clip ceiling block.

The Home Novelty Manufacturing Co. have moved into commodious quarters at the northeast corner of Tenth and Walnut streets. This company have undertaken the development of the Unicycle elevated railway system, which was the leading feature of the electrical section of the Exposition last October. A Unicycle motor car of full size is being constructed at their works and the elevated roadway is being erected at the yards of the Unicycle Elevated Railway Co., and all will be ready for a trial in a few weeks.

The American Electrical Manufacturing Co. have taken quarters at Nos. 2,011-2,017 Pine street, and are getting ready for the manufacture of electrical machinery and supplies, and arc and incandescent lamps. Ben. Nahm is president and treasurer; Joseph Wolf, vice-president; and Benj. Dubinsky, formerly with the Heisler Co., is secretary and electrician.

The Electrical Supply Co., of Chicago, continues to make a specialty of fuse wire, and is prepared to supply all sizes in any quantity. The facilities of this company for making accurately calculated fuse wire are unsurpassed and the high quality of the goods is acknowledged on all sides.

THE INSULITE SOCKET.

THE great desideratum in a lamp socket is the utmost simplicity and the fewest parts consistent with the efficient performance of its duty. Bearing this fact in mind, Mr. Thos. G. Roebuck has invented the socket shown in the accompanying illustrations.

The method of wiring the socket is exceedingly simple. For this purpose the cap is slipped over the wire pipe, the set screw B taken out and the insulated screw D loosened, as well as the screw E. One line wire is then inserted into the centre tube C, which is held in contact by the screw D. The other wire is then passed behind the screw E by the shoulder or lip of the contact spring. The socket is held firmly to prevent the wires from twisting while screwing the nozzle home on the line wire pipe; the set screw is then replaced which locks at half a turn of the nozzle.

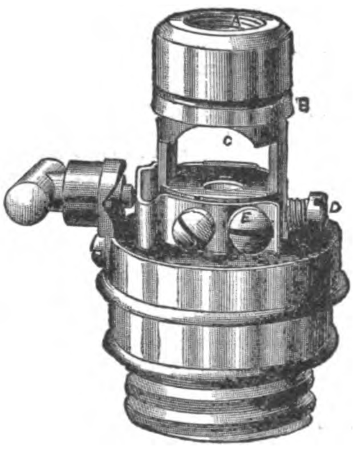


FIG. 1.—THE INSULITE SOCKET.

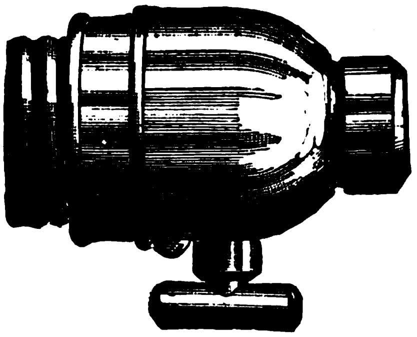


FIG. 2.—THE INSULITE SOCKET.

This simple socket is manufactured by the Insulite Manufacturing Co., of 35 Broadway, of which Mr. Thos. G. Roebuck is the sole selling agent.

COMPLIMENTING THE NEW YORK FIRE TELEGRAPHS.

The Board of Fire Commissioners has had entered upon its minutes, resolutions expressing its high appreciation of the zeal and ability shown by Mr. J. Elliot Smith, its superintendent of telegraph, in meeting promptly and successfully the serious emergency that arose through the destruction of the aerial fire wires and other circuits in the memorable snow storm of January 25.

BURNLEY DRY BATTERIES.

The Central Electric Company are in receipt of a letter from J. Parker & Son, Chicago, in which they state that they have had three Burnley dry batteries in constant use for two years, and that they have been successfully operating six 3 inch bells, which upon a test recently made, were working as satisfactorily as when first put in. They report the largest sales yet recorded on this battery during the month of February.

MR. A. E. HUNT, president of the Pittsburgh Reduction Co., intends giving a lecture on "The Prospects of the Use of Aluminum in Railroad Work," before the Railroad Club, on March 19.

NASSAU ELECTRIC CO.

The Nassau Electric Co. have removed their offices from 19 Park Place to 112 White street, where a full line of their specialties can be seen.

THE D. & H. C. COMPANY'S building at Albany is going to use Grimshaw White Core wire throughout, 100,000 feet being used. The work is being done by the Robinson Electrical Works, of Albany.

WESTERN TRADE NOTES.

THE MOSHER ARC LAMP CO., have produced a carbon that will burn fully twice the length of the ordinary carbon—sixteen to eighteen hours with a single pair of carbons. It will also burn with a very long arc without flaming, which, on incandescent circuits, means a great saving in power.

THE SUNBEAM INCANDESCENT LAMP CO., Manufacturers' Building, Chicago, are just putting in a new 200 h. p. engine and three large dynamos.

MR. J. R. BURDICK, of the H. W. Johns' M'f'g Co., of New York, has been a welcome visitor to Chicago, where he is well known among the electrical fraternity. The famous Vulcabeston insulation for magnet cores, arc lamps, and all purposes where an insulating fibre is required, is in great demand, and all the large electrical manufacturers are using it.

THE BAIN ELECTRIC M'F'G CO., 47 & 49 S. Jefferson street, are now comfortably installed in their new quarters. As heretofore, excellent work will be turned out and with increased facilities, orders for dynamos and motors of the largest size, mining and other special machinery, will be filled with greater promptitude than ever. Electric repairing will also receive the same careful attention. Mr. Bain, the president and engineer of the company, reports business as increasing very rapidly, and the out look is of the most promising and encouraging character.

THE CENTRAL ELECTRIC CO., Chicago, are showing a very unique and effective patented dust protector for contact points in bells, telegraph instruments, etc., which THE ELECTRICAL ENGINEER will fully illustrate when the cuts are prepared.

OKONITE.—For good construction in electrical apparatus where insulation is important, the famous Okonite wires admit no equal, and this is practically demonstrated by the orders for this wire during the dull season, when other things are suffering The Central Electric Company, who are the general Western agents, booked orders last week for more than 2,000,000 feet of varied sizes, the demand being unprecedented, proclaiming "Okonite still king."

THE ELECTRICAL SUPPLY CO., of Chicago, are having an excellent sale for their "Shield Brand" tape, and reports from those using it are highly satisfactory. The tape is prepared to offer insulating qualities similar to those of their well-known moisture-proof line wire, from which it takes its name. The E. S. Co. suggest that a cheap and simple method of discovering the virtues of this tape is to try a little.

MR. W. C. HAGAN, late of the Union Electric Co., at Pittsburgh, spent part of last week among the electrical fraternity in Chicago. He is now in business for himself at Pittsburgh, and has the agency for Simplex wire and a number of good specialties.

CUTTER'S new globeholders for T.-H. lamps, which we illustrated recently, seem to meet a decided want, as the orders for them are growing in number from week to week.

MR. J. H. COOKE has returned recently from a flying trip to Cincinnati and Indianapolis, where he secured some very handsome orders for the "Sunbeams," which in his well-known lamps he has managed to catch and effectually bottle up for distribution to central stations all over the country, which have suffered long enough from the thick clouds attendant heretofore on long lived lamps.

THE ELECTRIC CONSTRUCTION AND REPAIR CO., 205–207 Cana street, Springer Building, Chicago, are now manufacturing in large quantities an improved insulating paper for armature insulation. The paper is a non-conductor of heat, and is covered with a special material of remarkably high insulation, and impervious to moisture. The paper used is a fine quality of bond paper, consequently possessing great strength, and is specially prepared for this work.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. MARCH 18, 1891. No. 150.

A THOUGHT IN A LEISURE MOMENT.

BY

Wm S Eaton

WHILE in my laboratory, one day, I had occasion to await the development of a chemical operation then in progress. Casting about for something to occupy an idle moment, my gaze rested upon a small pile of iron turnings, some carbon plates, porous cups and various other odds and ends, and this is what I did.

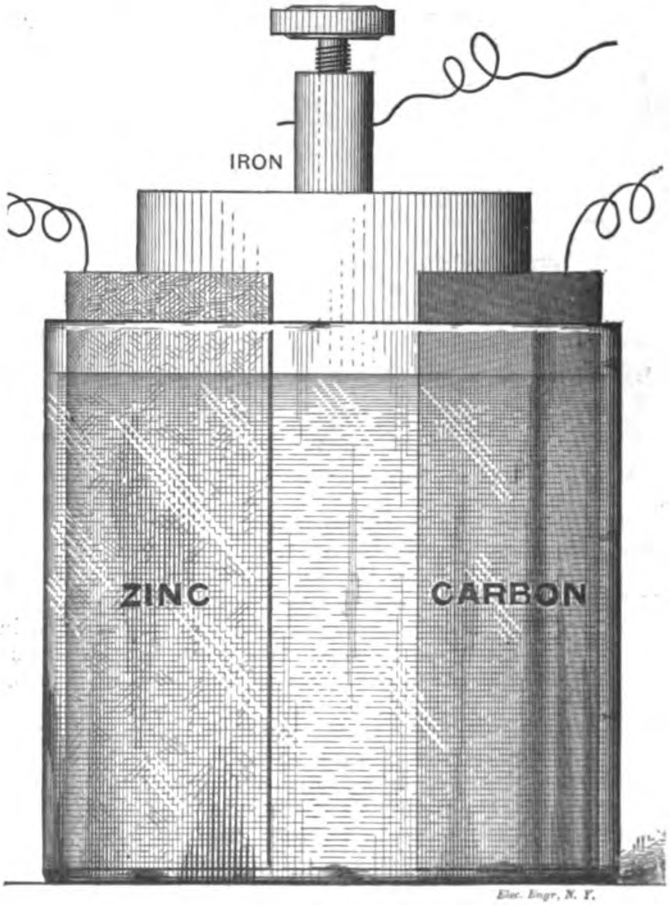
In the centre of a porous cup I placed a bar of ½-inch round wrought iron and rammed about it the iron turnings, to a depth of perhaps one-half an inch; then I dusted in some rouge, then more iron turnings, and so on, until the cup was full of the metal and rouge. By way of explanation, I will say that I did not stop to consider whether, or not, the rouge would be of any service; it was simply close at hand and in it went; nitro-glycerine or hair-oil would, in all probability, have taken the same road, had it been as accessible as the rouge.

My next move was to immerse the porous cup in a weak solution of sulphuric acid and water and pour a little extra into the porous cup for good measure. Next I inserted in the dilute solution outside the porous cup, a plate of carbon and a plate of zinc, the arrangement being shown in the accompanying illustration. I connected the wire from the zinc and iron electrode to a small vibrating bell and "let 'er go." It went; not very strong at first, but better after a little while, and in a few hours stopped.

The iron which had been the negative element of the battery became evidently as oxidizable as the zinc; so I disconnected the zinc and attached the carbon, thus making the iron the positive. This, of course, gave a stronger current than the first. Finally, this ran down and I switched back to the zinc again and got a better result than at the first trial; it seemed to run longer and give a better current. And so I kept changing from zinc to carbon alternately making the iron positive and negative.

For a single fluid battery I must say it did very well, and my recollection of it (this occurred many months ago) is that it ran with the iron as negative element, from Saturday noon until Monday morning. By that time its energy was almost gone; but I got a strong current when I switched the wires again, making the iron once more the positive element. It seemed to me that the iron filings had accumulated considerable electrical energy, and as soon as it was permitted it discharged itself. If such is the case, no doubt there was a large resistance when the zinc-iron elements were connected, which tended to reduce the effectiveness of the battery very materially. When the iron and carbon were connected there seemed to be a powerful rush of current for a short time. I never had the time to make any tests, and after a number of days I dropped it. These facts are as I remember them, and are in the main correct.

Although this experiment was ended almost as soon as begun, yet it made me consider the feasibility of employing, in primary or secondary batteries, some of the material usually accumulated in machine shops and elsewhere, and generally regarded as of no value. I also thought that the effectiveness of storage batteries might be increased, the weight reduced, and the cost lessened, by making up the electrodes of granulated, shaved, or otherwise prepared lead, instead of the plates and grids usually employed in that class of cells. I can see no great difficulty in forming a secondary battery of thin dividing partitions of porous earthenware, ramming in the lead turnings and adding the litharge and minium so as to incorporate the whole thoroughly. It is well known that in storage batteries generally the whole of the lead plate is not doing useful work. In the case of lead shavings, however, we get a greatly increased surface, and simplify the mechanical construction. We also avoid that fruitful source of trouble, buckling in the plates, and I think the weight would be diminished. It is equally true that there may be grave disadvantages attending such construction; yet, as the secondary battery has already proved its usefulness, any idea looking toward an improvement would appear to be worth an investigation.



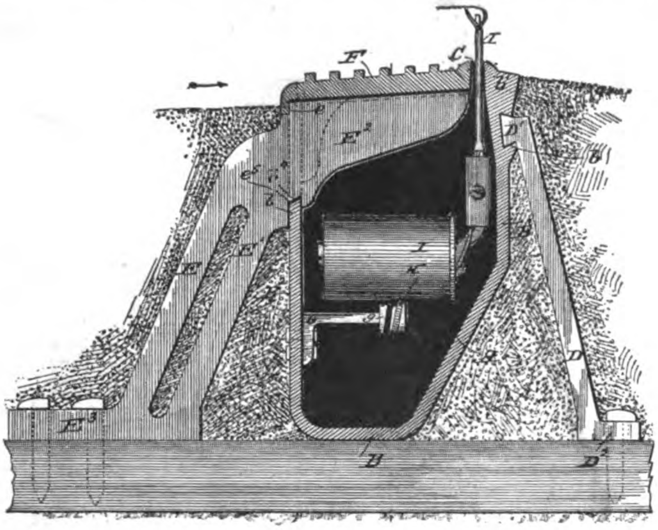
AN EXPERIMENTAL BATTERY.

BLACK'S ELECTRIC RAILWAY CONDUIT.

At the present day, when electric railways are coming into operation so extensively, and when the overhead wire is in many cases looked upon with disfavor by property owners, a practicable underground conduit is of the greatest importance. Mr. Bernard J. Black, of Richmond, Va., with this idea in mind, has designed the conduit shown in section in the accompanying illustration.

As will be seen, the conduit is formed of a series of essentially **U**-shaped metallic yokes B, which are each about four feet long and about one foot deep. The sides of each of the yoke sections extend up above the surface, and form the edges of the slot C. The wall B' of the yoke is provided with a horizontally-disposed dovetail groove *b*, in which are fitted the dovetailed heads D' of a brace-arm D, the lower end of which is anchored, as shown. These arms serve to brace one side of the conduit.

Metal brace-arms E are employed to brace the opposite side of the conduit, and also to serve as supports for the conduit covers. Each of these arms consists of a body portion E', about two inches in width, the upper portion of which extends inwardly, as at E^2, forming brackets for supporting the tops F of the conduit. These brackets extend across the top of the conduit, as shown, and form with the inner ends of the top plates the inner edge of the slot C. By this construction it will be seen that the conduit slot is placed at the inner end of the conduit instead of the centre, as is usually the case, for the purpose of preventing the jarring of passing vehicles from injuring the walls.



BLACK'S ELECTRIC RAILWAY CONDUIT.

Each removable top plate is four feet long, corrugated on its upper face to prevent animals from slipping, and provided with a depending lip which projects over the upper end of the side wall of the yoke, and is seated in a recess *e*, formed in the outer upper edge of the brackets. The upper faces of the bracket portions of the arms are provided with grooves or gutters, which serve to lead the water to one side and prevent it from entering the slot. In placing the conduit in position the concrete or other material forming the street-surface is packed about the conduit flush with the outer upper edge of the top plates, which are rounded, as shown, and form, therefore, practically no obstruction to a vehicle passing in the direction indicated by the arrow.

Vehicles going in the opposite direction, when passing over the slot and coming against the wall, tend to force the end down and make the slot-opening irregular. To securely brace the slot wall, therefore, the plates are provided with depending lugs which rest against the inner face of the yoke, throwing the strain against the conduit wall.

The horizontal brackets, G, support the trolley wire, which is wound about the insulators so as to avoid unnecessary slack. The trolley I is arranged to project laterally and travel on the top of the wire.

This trolley is the joint invention of Mr. Black and Mr. Wilton F. Jenkins, of Richmond, and is detachably connected with the car body, so that, in case of the car leaving the track, the mechanism may not be injured, nor the circuit broken.

THE PROTECTION OF CROSS COUNTRY WIRES.

BY

W. M. Miner

I SHOULD like to say a few words on a subject that is beginning to agitate the minds of some of the electrical engineers of this country, namely:

What shall be done to protect the telegraph and telephone wires from the damaging effects of the snow and sleet storms, such as lately laid low a good share of the wires throughout the country?

I have noticed one or more articles on the subject, which seem to point a little towards a plan I have had in view for some time past, and which may be of interest, as it is, I believe, superior in several respects to any I have heard of. My plan is this:

For all lines alongside and adjacent to the railroads, substitute several cables of a few wires each, supporting these cables by posts of wood, or metal, extending alongside of the track a few feet from the rails, or to timbers and walls, when necessary, eight or more feet apart; cross pieces, for the cables to rest on, being fastened 12 or 18 inches above ground. If preferred, wood or metal troughs or conduits could be secured to these posts, and the cables laid therein. They should be of two or more parts, permitting easy access to the cables.

The advantage of running the cables so near the ground is, the very slight chance there would be of derangement by falling so short a distance to earth. They would work the same even if lying on the ground for a short distance, and for the short time necessary before repairs could be made. If entirely buried in snow and ice, they would continue to work, unless broken, in which case they would be more convenient to handle.

At road crossings and stations the cables could be elevated to poles, high enough to clear all vehicles, etc., or run underground for a short distance.

In using cables composed of a few wires each, repairs would be easier and less expensive to make than if composed of a large number of wires.

Different systems could use different cables, and not be so apt to interfere with each other, as they probably would do if all were bunched in one cable.

At present the available space along most of the railroads is nearly, or quite, taken up by the pole lines, and the poles are nearly all overloaded, making it necessary for some of the lines to follow the highways, go across lots or any way to get there, when the railroad is the shortest and most preferable route.

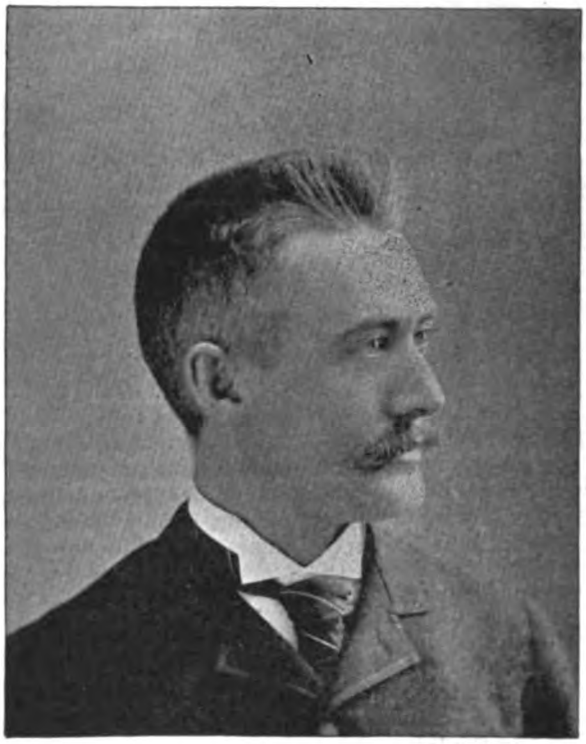
By the proper use of cables these lines could all be placed along the railroads. Of course, lines branching off to small towns off the routes of railroads would be run on poles as now, but few of these towns so situated would require more than one or two wires.

The cost seems to be the greatest drawback to any plan of this kind, but the damage due to a general breakdown of wires, and stoppage of communication, such as has occurred twice or more within the last three or four years, would go far towards paying for such a system as I suggest.

ELECTRICAL ENGINEERS.

FRANK B. RAE.

THE portrait shown on this page is that of Mr. Frank B. Rae, whose electric railway system is being rapidly introduced in different parts of the country. Mr. Rae was born July 25, 1854, at Elmira, N. Y. His father was an English mechanic who had emigrated to this country, and his mother was an American of English parentage. The boy attended the common schools until he was about 12 years old, when his parents removed to Syracuse, N. Y. When fifteen years old he succeeded in securing also about three months in mathematics at the business college, but beyond this he did not enjoy the advantages of regular tuition. At the age of sixteen Rae obtained a position as messenger boy with the Atlantic and Pacific Telegraph Company, at Syracuse. He manifested considerable aptitude for telegraphic work, and after carrying messages for only a month or two, was made batteryman and repairer for the division. Mr. Rae had served perhaps a month or so in this capacity when he was pulled from a thirty-foot pole by a horse car and slightly injured. He has, since that time, taken noble revenge by doing his share in banishing the horse car from our streets. The immediate result of the accident was that it gave him an opportunity to learn practical telegraphy, and upon his recovery he became a railroad operator upon the New York Central Road. In 1872 Mr. Rae returned to the Atlantic and Pacific Company, at Albany, and later was installed at Syracuse as manager. In 1874 he became associated with the Western Union Telegraph Company, in this city, and learned to operate the printing instruments. In 1876, in connection with Mr. C. H. Davis, he published a very useful book of "Diagrams and Connections." This literary effort attracted attention and helped him to obtain a position in San Francisco as quadman. The work that he did there in making the then new system successful, came to the notice of President Orton while that gentleman was visiting the Pacific Coast, and Mr. Rae was appointed electrician for the Western Union Company in that Division. He served in this capacity until 1879 or 1880, when he went into the employ of the Brush Electric Light Company, of San Francisco, and in 1882 he took charge of the Brush plant at San Jose, where he erected one of the first high towers used for city lighting.



Frank B. Rae

In February of 1883, Mr. Rae came East to obtain some patents on devices that he had invented, and had the good fortune to meet Mr. Stephen D. Field, with whom he had already been acquainted in San Francisco. It had been his intention to return to the Coast, but he was induced by Mr. Field to remain in New York. In 1883 he was sent by Mr. Field to Chicago to build the electric railway for the Chicago Exposition of Railway Appliances, and there, with Messrs. Mailloux and Healy, he put in operation the road equipped with the motor "The Judge," which, during the continuance of the exposition, a period of two weeks, carried nearly 27,000 passengers. The road was about one-third of a mile long, and the track was laid on the third rail plan. The average speed maintained was eight miles an hour. This practical piece of work attracted considerable attention, and was followed up by the operation of "The Judge" immediately after at the Louisville Exposition, where Mr. Rae also had charge of the work.

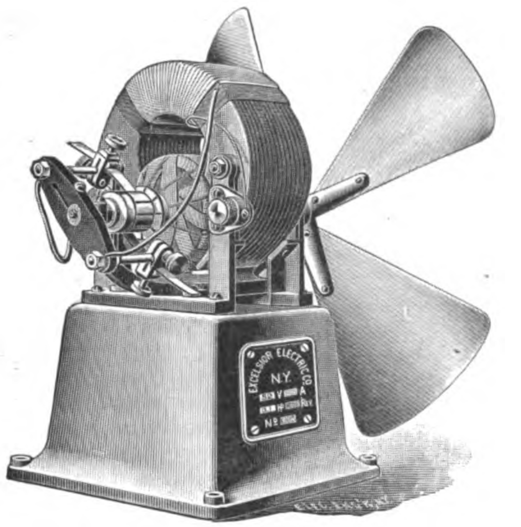
Returning to New York, Mr. Rae was associated with Mr. Field in the perfection of the Field system of stock printing telegraphs, acquired and operated by the Commercial Telegram Company, and Mr. Rae, for some time, was in charge of the large central office at the foot of Broadway. Having put this plant in successful operation, Mr. Rae went into the electrical engineering business with Mr. C. O. Mailloux, and then became electrician, in 1886, for J. H. Bunnell & Co., of this city.

At this time a very tempting offer was made to him in connection with the celebrated Barker-Mitkiewicz concession in China, and he was one of the electrical engineers dispatched by Count Mitkiewicz to the Celestial Empire to bestow on the Chinaman the blessings of telephony and other modern electrical inventions. Mr. Rae proceeded, by way of Suez, to China, and after a stay in that country, which was very brief, owing to the failure to convince the Chinese that they wanted any of the Mitkiewicz blessings, Mr. Rae finished his circumnavigation of the globe by returning home via San Francisco. He had barely landed in this country before he was summoned to Chicago to apply the dynamo to the stock printing telegraph system of the Western Union Company. While there he was employed as an expert to report upon the electric railway system of the Detroit Electrical Works, and did his work in such a satisfactory manner that he was subsequently requested by the Detroit concern to undertake for them the production of a new system. He consented, and in November, 1888, settled in Detroit, assuming charge of the inventing and electrical engineering of the railway department of the Works. Since that time the Rae system has become very widely known, and it is now in use on a large number of roads, in such cities as Cleveland, Galveston, Columbus, O; Portland, Oregon; Colorado Springs, Detroit, Fort Worth, East Reading, Pa.; Joliet, Ill.; while contracts have also been taken for Rochester, South Chicago, Elkhart, Ind.; Adrian, Mich.; Decatur, Ill.; Kansas City, Nashville, Tenn.; Aurora, Ill.; Sault Ste. Marie, Mich.; Springfield, Ill.; Springfield, Mo., and other places. There are a great many individual and distinctive elements in the Rae railway system, and one of the most notable features, to which Mr. Rae has steadfastly adhered, is that of equipping each car with but one motor, the motor being suspended lengthwise the car and driving upon each axle equally by means of bevelled gear, so that there is a material reduction in gearing and in number of wearing parts.

Enough will have been said to show, that in spite of the fact that Mr. Rea is still quite a young man, he has had a very active, eventful and noteworthy career. It may be stated, moreover, that in addition to his motors and railway system, he has invented a number of electrical appliances and devices, among which may be mentioned the Rae "Horn ammeter," illustrated and described in our columns last year.

THE HOCHHAUSEN ALTERNATING FAN MOTOR.

THE wide-spread use of the alternating current has created the demand for its application to the operation of motive power apparatus, and one of the largest fields in this direction, so far, is its application to the driving of fans for ventilating purposes. In keeping, therefore, with the progress of the times, Mr. William Hochhausen, of the Excelsior Electric Company, of this city, has designed the simple little alternating fan motor, illustrated in the accompanying engraving. In this little machine the field-magnet is built up of laminæ of thin sheet iron, and in this way they are fitted for the magnetization by the alternating current, without becoming heated in the least.



THE HOCHHAUSEN ALTERNATING FAN MOTOR.

The magnet, as will be seen, is wound at the top with only 4 ounces of wire. The armature is of the Siemens drum type, and so wound that contiguous wires have but a very small difference of potential between them, thus preventing burn-outs. It is wound in 16 sections and has only 6 ounces of wire on it, being provided with a commutator, and running at 50 volts, for which the motor is designed. The fan revolves at 1,000 revolutions per minute, and the motor is self-starting under full load, consuming no more current than a single incandescent lamp.

The motor itself weighs only 10 pounds, and the base 5 pounds additional, making 15 pounds in all. Although diminutive in size, the mechanical details have been thoroughly worked out, and in addition to its other qualities, it has self-oiling bearings, so that it practically requires attention only at very long intervals. The motor, which we have recently seen in operation, runs without the least sparking.

MAGNETIC ROTATION.

BEFORE the Chemical Society a paper on "Magnetic Rotation" was read by Prof. W. Ostwald, of which the following is an abstract: "The magnetic rotation of organic compounds, according to Perkin, is an additive function of their composition and equal to the sum of the rotations of the components, but this is not the case with the rotation of inorganic compounds, which is usually found greater than that calculated on such an assumption. In the case of hydrogen chloride, for instance, the calculated value is about 2.18, and as a matter of fact the value obtained for hydrogen chloride dissolved in an organic solvent, isoamyl oxide, is 2.24, but when dissolved in water the value found is from 4.05 to 4.42, increasing with the dilution. The author points out that these exceptional values are only obtained in the case of electrolytes, and that they must, therefore, be referred to a fundamental difference existing between the constitution of electrolytes and that of non-conductors. That such a difference exists has been already deduced from other considerations, and has led Arrhenius to the formulation of the theory of electrolytic dissociation. The author claims that the facts established with regard to magnetic rotation are in perfect accordance with this theory, and that any exceptional values in the magnetic rotations of electrolytes are due to the occurrence of electrolytic dissociation."

THE GIBBS DENTAL MALLET.

THE relief obtained by the dentist in the substitution of electric drills and mallets in place of those driven by foot power, as heretofore, has made the former the favorite method, and no dentist who pretends to keep up with the times is now without an electrical outfit. The dental mallet has been the subject of a variety of designs and modifications, but one of the most simple and efficient which has come under our observation is that designed and manufactured by Mr. Wm. E. Gibbs, of this city. This mallet is illustrated in the accompany engraving, and its operation is as follows:

The current entering the lower binding screw, shown in the illustration, passes through a circuit breaker into the coil of an electro-magnet, which slides easily in the hollow handle, thence through a retractile spring connecting the lower end of this magnet with the heavy iron nozzle of the instrument, and traverses the case itself to the other binding screw. The movable mallet being magnetized by the action of the current is drawn down suddenly, and delivers a blow upon the inner end of the chuck which holds the point, at the same time breaking the circuit and allowing the retractile spring to push it back to its original position, when, the circuit being again complete, the blow is repeated.

In order that the circuit shall not be too quickly broken, and also to provide means for regulating the force and rapidity of the blow, the circuit breaker is made of iron and follows the mallet by magnetic attraction until stopped by a shoulder, when a spring takes it back to its former position. The set screw in the head regulates this movement.

THE GIBBS DENTAL MALLET.

Being round and smooth, and without external coils or projections of any kind, the mallet accommodates itself readily to the hand of the operator. The blow is rapid and positive and its force and rapidity may be regulated from the lightest and quickest, to the heaviest and slowest in a moment by means of the adjustment screw between the binding-posts, and further increased or diminished by the amount of hand pressure exerted upon the filling in the tooth.

A push-button of convenient shape lies near the chair, within easy reach of the foot, and the current is supplied by twelve cells of No. 2 Samson battery.

THE MEYLAN-RECHNIEWSKI ELECTRIC ENERGY METER.[1]

BY E. MEYLAN.

As is well known, electric meters may be divided into two great classes, the continuous integrators and the discontinuous integrators, or the automatic reading instruments.

The first are represented at present by the chemical meters, and by what are sometimes termed motor-meters; they are characterized by the fact that the instrument gives at each instant the quantity sought, that is, $\int C\ dt$, or $\int E\ C\ dt$, according to the case, and this either by the accumulation of a metallic deposit, or by the fact that the speed of a movable part is at each instant proportional to the electric energy or to the current. The meters of the second class play the part of an operator, taking off at certain equal intervals the figures of the electric energy or the output, the instrument automatically carrying out the summing up of these variable quantities.

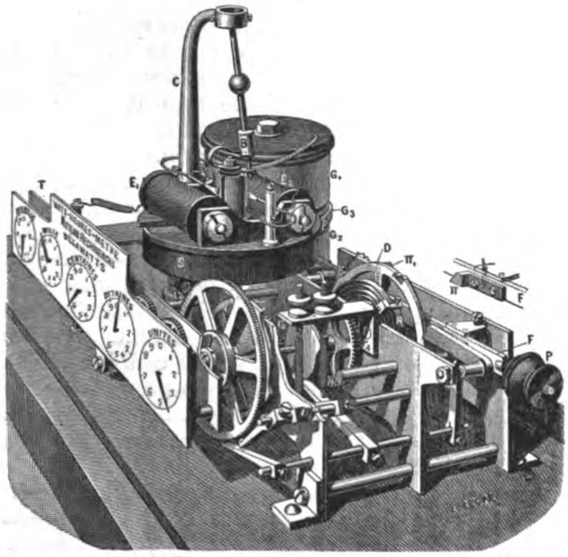


FIG. 1.—THE MEYLAN-RECHNIEWSKI ELECTRIC METER.

The meter constructed by us is of this latter class.

The most important part of the automatic reading meters is the motor, which usually is called upon to furnish, by the constancy of its speed, the equal intervals of time which separate the readings, or rather the equal intervals of time during which the readings take place. In all the meters with which we are acquainted this is done by a clockwork movement wound up by an electric device furnished with a regulator, or by an isochronous motor for discontinuous currents. Now, these arrangements present two distinct disadvantages, the first, and most apparent, being that which results from the electric contacts and the sparking. In spite of all precautions these contacts gradually become dirty and cease to act; moreover, the motive force being essentially intermittent, it is necessary to be absolutely certain that it will act in the position last taken by the moving part each time it returns to a state of rest. The second difficulty is the regulation of this motor; none of the simple regulators employed in clockmaking are efficacious, except within very narrow limits, and it is therefore necessary to make the motor act upon the contacts, in order to make the number and the duration of the electric impulses vary with the variations of the mechanical resistance of the apparatus.

We hope to obtain a better result by using a more robust piece of machinery in the shape of a Gramme motor, which gives no sparks and has no dead point. To adapt it entirely to our needs it is sufficient to add two arrangements—one destined to make the starting certain, the other to regulate the speed.

A motor taking a constant current, supplying the very variable work necessary to take the readings, and giving at the same time the time factor, has, furthermore, the advantage, by no means negligible, of being able to be inserted directly in the shunt circuit, which is needed for the wattmeter, so that in this way one shunt circuit is all that is required.

The Meylan-Rechniewski meter, of which Fig. 1 gives a general view, comprises six principal parts:

1. An electric motor, M, Fig. 2, with permanent current and constant speed.
2. A train of wheels, reducing the speed of the motor and communicating to a final or principal axle, A, Fig. 3, a strictly uniform and continuous rotation, of which the speed is one-third revolution per minute.
3. An electro-dynamic balance—a wattmeter formed by one or two fixed coils, G_1, G_2, traversed by the main current, and a movable coil, G_3, fixed to a beam, F, mounted upon a pivot or upon knife-edges; this balance gives rise, under the action of the main current and the shunt current, to a force proportional to $E\ C$, a force which is balanced by a fixed counteracting force.
4. An elastic cam; this is the part of the apparatus which works the readings of the balance.
5. A gearing arrangement controlled by two detents, communicating to the first moving part of the register, T, the movement of the principal axle during the period of each reading of the balance. The action of the detents is dependent upon the movements of the principal axis of the elastic cam.
6. A integrating register whose various dials show in hecto-watts the consumption of energy in the circuit upon which the meter is connected.

The motor is of a special type. Fig. 2 gives a section and partial elevation, which will serve to make its action clear. It is a disc motor, but one in which the two field magnet poles are on the same side of the armature, that is to say, above the latter; this arrangement gives rise to a real uplifting of the armature core under the action of the magnetic field. This considerably relieves the jewel upon which the pivot rests.

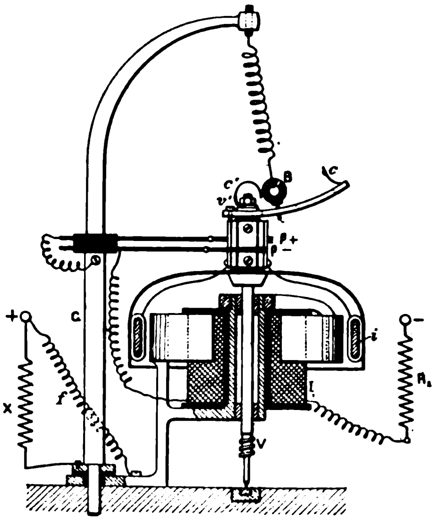


FIG. 2.—THE MEYLAN-RECHNIEWSKI ELECTRIC METER.

The field magnet system comprises two semi-circular pole-pieces, connected together with two square pieces fastened by two bolts, which form the cores of the two electro-magnets, E_1, E_2, Figs. 1 and 2.

The armature is a flat ring of iron, insulated and wound

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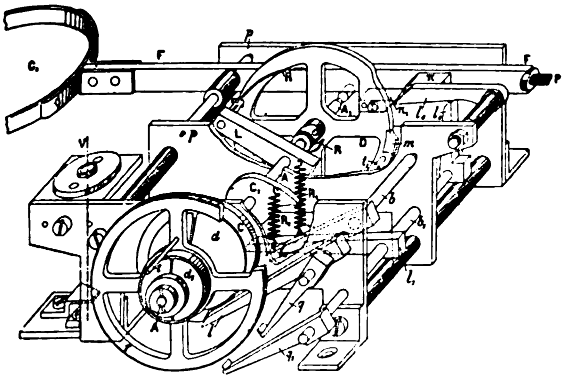
[1] Abstract from the *Bull. de la Soc. Int. des Electr.*

with 3,000 turns of fine wire, forming five or six segments, connected to an ordinary commutator. This armature is carried in an ebonite support, mounted upon the axis, V, whose endless screw works the wheels, $r_1 \ldots r_4$, Figs. 1 and 3.

The field magnet is fixed to the pillar or standard, C, which also carries one of the brushes, $\beta +$. The second brush is held by an insulating support. These brushes are formed of an elastic wire terminated by a flat pinch of silver wire of .15 or .2 millimetre diameter.

The system of regulation consists in periodically shunting the coils of the armature. This result is obtained very simply by connecting one of the commutator plates to the insulated passage which pulls round the conical pendulum which is used as a speed indicator. One of the brushes ($\beta +$) being itself connected to the ball of this pendulum, it will be seen that when the ball, B, touches the contact, c, a part of the shunt current passes outside the armature. For instance, when the plate is under β —, the current goes by way of X, C, B, c, β —, to the field magnet, I, without passing through the armature. On the other hand, when this plate is beneath $\beta +$, the shunt current passes entirely into the armature.

On an average, a decrease of about 50 per cent. of the motor energy is thus produced, which is sufficient, generally speaking, to maintain the speed practically constant within fairly large limits. For a variation of 17.7 per cent. of the volts, the variation of speed was only 2.2 per cent.; in the practical limits of electric lighting, even with a total variation of 10 per cent., the maximum possible error under this head would be only about 1.5 per cent.



. FIG. 3.—THE MEYLAN-RECHNIEWSKI ELECTRIC METER.

The sparking at $c\,\beta$ is absolutely invisible, for it only takes place from the breaking of a circuit traversed by .025 ampere; moreover, the contact is always perfect; and, lastly, the current is never entirely broken, as is the case in the well-known arrangement of Marcel Deprez. On the other hand, it may be considered as practically constant when care has been taken to give the armature a resistance relatively small compared to that of the whole circuit.

The regulator has yet a further purpose, that of assuring a sharp starting of the motor by giving rise to a strong increase of the shunt current while yet the ball has not quitted its central support. This is brought about by a contact, c^1, connected with the axle of the motor, and thence through the body and the wire, f, with the outer extremity of a resistance, X. The other extremity of this resistance being connected to the standard, C, it is seen that so far as concerns the contact between B and c^1, the resistance, X, is shunted, and the shunt circuit then only includes the motor and the rheostat, R_1. The motor therefore rapidly gains its normal speed, and there is never the slightest fear of a misstart.

In the case when it is desired that the meter should act with very variable differences of potential, a *double slotted way* is employed, that is, a passage formed by two parts connected with two plates diametrically opposite. From 90 to 140 volts, the variation of speed is about 2.5 per cent. only, *i. e.*, for a variation of 50 per cent. in the potential.

The electro dynamic balance of the instrument is seen to the left in Fig. 1. The fixed coils, G_1 G_2, are formed by insulated copper strips wound on a central wood core. The two coils are connected so that the actions are added together, and that the force acts upwards. The current is taken from two brass blocks pierced with holes, into which the cables are fixed and tightly screwed by a set screw.

The movable part is formed by a roll of fine wire, G_3 carried upon an ebonite support fixed to the arm by a metal ring rivetted to this latter. This part can be seen in Fig. 3. The current is led to the coil on one side by the pivots, and on the other side by a band of very flexible tinfoil, fixed upon an insulating support near to the axis of suspension. The movable coil is balanced by a counterweight screwed to the end of the arm, F. The engagement of the arm, F, by the elastic cam is brought about by a piece of steel, π, fastened to this arm.

The elastic cam, Fig. 3, comprises the disc, D, carrying the steel cam, π_1, the spiral spring, R, the axle, A_1, and a clutch, L, which connects it to the principal axle, A. The axle, A_1, is carried directly on the end of A between points or on pivots. While the cam, π_1, does not meet the piece π of arm F, the spring, R, is not twisted, and the shaft, A_1, participates in the movement of the axle A. At the moment of contact, on the contrary, the cam is stopped and the spring is twisted through an angle proportional to the pressure that the arm exercises originally upon its acting end. At the moment when the cam raises the arm the reading is finished.

The regulation of the instrument is brought about very simply by assuring the simultaneous freeing of the detent q and the re-engagement of the detent q_1, when the electrodynamic pressure is nil; this regulation is brought about by the position on the shaft of the cam c and the adjustment of the weight, P.

As we have said, the motor is wound in series, and forms part of the fine wire circuit of the wattmeter and a rheostat. The connections of the shunt circuit are therefore those of Fig. 2, of which X would represent a rheostat and R_1, the coil of the wattmeter.

Each meter carries four terminals; the two first to the left, which are insulated, correspond to the positive main, and the positive wire to the lamps; they are connected by the thick wire of the galvanometer. The two others, which together form one connection, serve to fasten the negative main and the negative lamp wire. The shunt circuit is connected on one side to one of the positive terminals, and on the other to one of the negative terminals.

The calibration of the meter is made in such a manner that the first dial of the register indicates a multiple or a decimal part of the electric unit of work, the hecto-watt-hour (1,000 watt-hours).

Thus, for meters of lower capacity (100-110 volts 12 amperes), one division of the first dial corresponds to a deca-watt-hour (10 watt-hours). This calibration is made, for a type once settled upon, by altering in the desired direction the total resistance of the shunt circuit, which is about 2,000 ohms, the speed of all motors being regulated previously so that the rotation of the main axle is made once in three minutes.

Our first model of meter, the ratchet wheel of which has 300 teeth, measures from unity to 70 or 80; furnished with a galvanometer, whose resistance is 0.01 ohm, it forms our type of 12 amperes, and is capable of measuring from one lamp of 8 c. p. (30 watts) up to 40 lamps of 8 c. p., or 20 lamps of 16 c. p.

The principal constants of this type are:

Periodicity of readings............	3′
Constant	1 division = 10 watt-hours
Resistance of shunt circuit..........	2,350 ω
Resistance between terminals........	0.01 ω
Maximum loss of volts..............	0.12 volt
Loss empty (100 volts)...............	4.5 watts
Maximum loss (100 volts 12 amperes)	4.5 + 1.5 = 6 watts
Maximum electro-dynamic couple...	60 gramme-centimetres.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—XVII. (*concl.*)

(*Copyright The Electrical Engineer.*)

BY

Herbert Laws Webb

SIMPLE RULES FOR CONNECTING UP.

In working with portable sets the following simple rules for connecting up will be found of use:

Galvanometer Constant:—Connect one pole of battery to galvanometer, second pole of battery to high resistance, second terminal of galvanometer to second terminal of high resistance; shunt and short circuit key to be bridged across galvanometer circuit.

Insulation:—Connect one pole of battery to galvanometer and the other to earth; join the cable to second terminal of galvanometer; shunt and short circuit key as before.

Condenser Discharge:—Connect "earth" block of condenser, one terminal of galvanometer and one pole of battery together; front block of condenser to lever of discharge key, second terminal of galvanometer to upper contact, and second pole of battery to lower contact of discharge key.

Capacity of Cable:—Connect one pole of battery and one terminal of galvanometer to earth, substitute a cable or lead for condenser at lever of discharge key; other connections the same as in taking discharge of condenser.

Conductor Resistance:—If cable to be measured is single and grounded at distant end, connect as follows: Join one pole of battery to centre of proportional arms of bridge and other pole to earth. Connect cable to extremity of left hand proportional arm, and extremity of adjustable coils to earth. One terminal of galvanometer is connected to extremity of each proportional arm.

If the cable to be measured is double and looped at the distant end, the only difference in the connections will be to join second cable-end and second pole of battery to extremity of adjustable resistance coils, removing the earth connection at this point.

In setting up the instruments the first operation will always be to connect the shunt to the galvanometer, and the short circuit key to the shunt; when this is done the terminals of the short circuit key correspond practically to the terminals of the galvanometer; therefore all galvanometer connections are most conveniently made direct to the short-circuit key.

CARE OF INSTRUMENTS AND CONNECTIONS.

In connecting up instruments either for temporary or permanent use, trim the ends of all wires carefully, tapering the insulation back from the bared portion of the wire, so as to leave no loose shreds of insulation or braiding to make contact with binding posts or other parts of instruments and thus give rise to surface leakage. Always bend wires around binding posts from left to right, so that when the nut is screwed down it will tend to grip the wire firmly and not to loosen it or push it back, as would be the case were the wire bent round from right to left. This point is one of special importance when dealing with stranded wire.

Keep the hard rubber pillars, bases and tops of keys and other instruments thoroughly dry and clean. It is very difficult to prevent dust from lodging on the instruments, as some of the parts are very difficult to get at, but a little careful attention every day with a camel's hair brush and a piece of chamois leather will go a long way toward keeping the instruments in good condition and always looking clean and bright. When not in use the instruments should always be properly covered up. If work is being done every day it is better to dust twice a day—in the morning before beginning work and in the evening before covering up. In any case the morning inspection and dusting should never be omitted.

When the instruments are not in use, all plugs should be kept in position to prevent dust from being deposited in the sockets; dirty plugs and sockets introduce extra resistance. The plugs should be cleaned occasionally with very fine emery paper. The sockets should also be cleaned from time to time in the same manner. This can be done by means of a small wooden plug of a size to fit loosely in the socket; by slitting the plug part of the way up, the edge of a strip of emery paper can be held in the plug and the strip wound round it. With this the sockets in the brass blocks can be thoroughly cleaned. If the plugs and sockets are kept clean there will be no danger of introducing extra resistance from bad contacts and accurate measurements can be depended upon. The platinum contacts of the keys should be cleaned occasionally by rubbing with a piece of ordinary unglazed writing paper, or, if they have become very dirty, with very fine emery paper. Keys with rubbing contacts will seldom need this attention, as the contacts are kept clean by the friction of the two surfaces. When ordering keys it should be insisted that all the fixed parts of brass be secured to the hard rubber pillars by means of steady pins. If the steady pins are omitted, the levers, contact plates and bridges will soon work loose and shift round—a very annoying and troublesome defect.

The bases of keys and other light instruments are generally drilled at the corners so that they may be screwed down to the table. A better plan, which will insure more thorough insulation, can be adopted if the instruments are to be used permanently in one place. This is to have the bases made solid, *i. e.*, without holes, and to stick the keys to the table with Chatterton's compound, or some similar elastic glue. In damp places the insulation of the instruments can be improved by covering the table with a sheet of gutta percha before setting up the instruments.

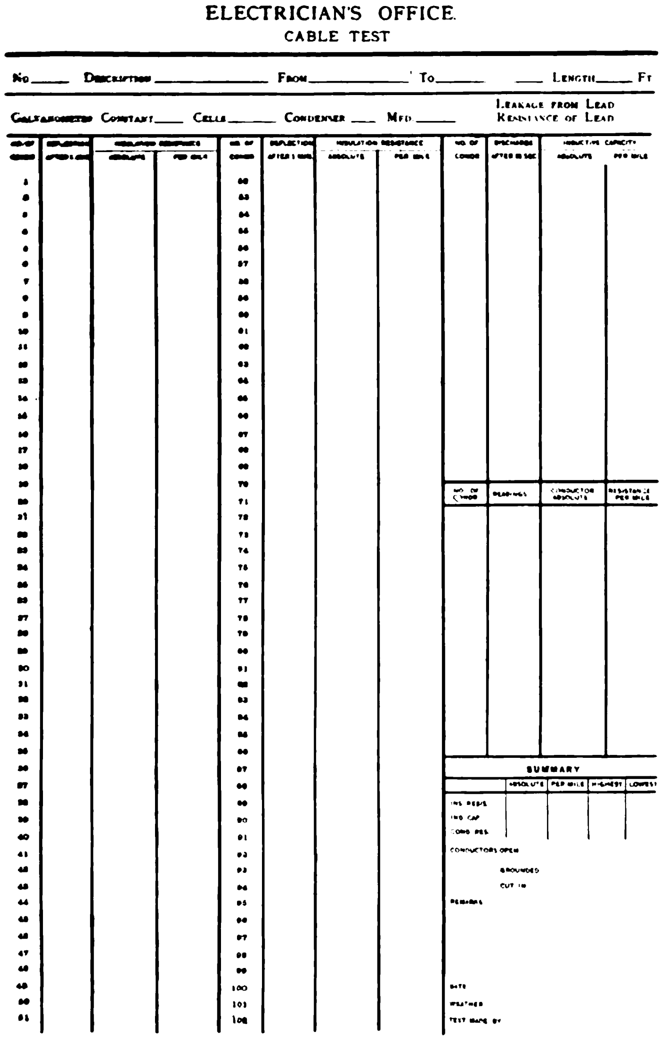
RECORDS AND REPORTS OF TESTS.

In keeping records and making reports of tests for future reference, or for the information of others, care should be taken to make the information recorded as full as possible, so that all the data that can possibly be required at any future time may be always accessible. In making reports or entering up records of tests there can be no greater error on the part of the observer than to imagine, because certain data are quite well known to him, that there is no necessity to write them down, as he can always remember all about the matter himself. The object of keeping records and making reports is to furnish other persons with full information on the subject; and the records should be so written up that anyone needing to refer to them five, ten or twenty years after, might be able to readily ascertain the whole history of any cable tested, the conditions under which the test was made, and, if he found it desirable so to do, to check the figures and work out the test for himself.

This can only be made possible by inserting in the records all the details of the construction of the cable, such as size of the conductor, style and thickness or weight per mile of insulation, length of cable, etc., and all the figures referring to the test, such as battery power, resistance and shunt used in taking the galvanometer constant, battery power and shunt used in taking insulation test, leakage from lead, resistance and capacity of lead, capacity of condenser and battery power used in taking discharge from standard condenser. The state of the weather and the temperature should also be noted. When these data are all correctly given, a record of a test has permanent value; when they are omitted or given incorrectly, or in such form as to leave room for doubt as to their exact meaning, the record is almost useless for reference, as little dependence can be placed on a "bald and unconvincing tale" in which results only are given.

Another bad practice in writing up records, almost as reprehensible as that of suppressing information, is that of using abbreviations which are understood only by the inventor or abbreviator. All remarks should be written in plain English, and, where abbreviations are used, they should be only such as are customary and "to be understanded of the common people."

In making a report of a new type of cable it is necessary to enter more into detail than in reporting the test of a cable of well-known and frequently used description, particularly if the new cable is supposed to embody any special advances over previous methods, or if valuable advantages are expected to be derived from its adoption. In such a case it is necessary, besides giving a full report of the electrical tests, to make a detailed description of the mechanical construction of the cable, specifying the number, size and weight per mile of conductors; the nature of the insulating material, and the thickness and weight per mile on each conductor; the method of laying-up the conductors; style and amount of material used for outer protection; weight of complete cable per foot or mile, etc. Reports of this kind will, of course, vary in each case, but the point is that it should always be borne in mind that an electrical test alone does not give sufficient data on which to base an opinion of the merits of a new type of cable.


ELECTRICIAN'S OFFICE.
CABLE TEST

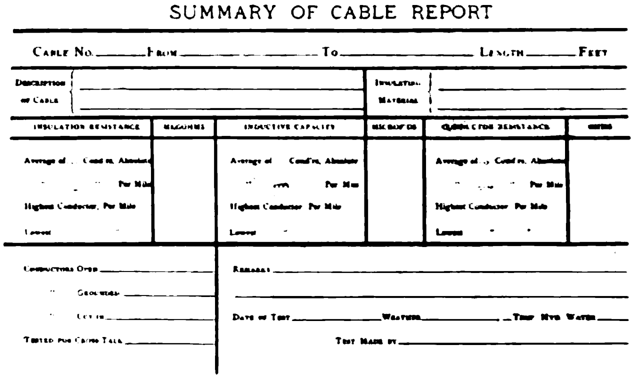
No.____ Description ____________ From ____________ To ______ ____ Length ____ Ft.
Galvanometer Constant ____ Cells ____ Condenser ____ Mfd. ____ Leakage from Lead / Resistance of Lead

FIG. 37.

When the report deals only with a test on a cable of standard type, there is no necessity to enter all the mechanical details; it will be well to consider, however, the entries which should always be made, and these will serve as a guide for drafting forms for test blanks and record books.

Topographical Data:—Name or number of cable, location of terminals, and length of cable.

Mechanical Data:—Type of cable, manufacturer's name, number of conductors, size of conductors, thickness of insulation, description of insulating material, description and thickness or weight of outer covering. In some cases the name of the cable, if some conventional trade name is used, will be sufficient to indicate by whom the cable is manufactured, and also its general mechanical construction, as such cables are generally made to a standard specification which is only departed from when improved methods of manufacture render it necessary or advisable to amend the specifications.


SUMMARY OF CABLE REPORT

Cable No. ______ From ____________ To ____________ Length ______ Feet
Description of Cable ____________ Insulating Material ____________
Conductors Open ______ Grounded ______ Cut in ______ Tested for Cross Talk ______
Remarks ____________
Date of Test ______ Weather ______ Temp. Hyd. Water ______
Test Made by ____________

Insulation Resistance
Megohms
Inductive Capacity
Microfds.
Conductor Resistance
Ohms
Average of Cond'rs, Absolute
Per Mile
Highest Conductor, Per Mile
Lowest

FIG. 38.

Electrical Data:—Galvanometer constant, stating battery power, shunt and resistance used and deflection obtained. Leakage from lead taken with full battery. Discharge from lead taken with same number of cells as used in capacity test. Resistance of lead. Discharge from standard condenser, stating battery power, capacity of condenser used and deflection obtained. Deflection for insulation on each conductor and insulation resistance, absolute and per mile. Discharge deflection on each conductor and capacity, absolute and per mile. Resistance of each conductor (or loop) with lead, absolute resistance (lead deducted) and resistance per mile.

General Remarks:—Make note of any conductors open or grounded, number of working wires in cable, or anything in the condition of the cable likely to affect the test. Note the condition of the weather and the temperature of the air, and of the hydrant water if the cable is laid underground or of the tank water if the test is made in the factory. Note the date of the test and name of the person who makes it.

It is useful in the case of a cable containing a number of conductors to add a summary giving the average insulation resistance, capacity and conductor resistance of all the wires tested, and the highest and lowest results in each test. This shows at a glance the general condition of the cable.

In preparing a test sheet for filling in the above information, the heading should contain the spaces for the description of the cable, route, location of terminals, length, mechanical details, etc. Immediately below should be the spaces for galvanometer constant and condenser discharge, and particulars of the lead, *i. e.*, its leakage discharge and resistance. The rest of the sheet should be ruled in vertical columns for insulation resistance, inductive capacity and conductor resistance, a column being made for the conductor number, another for the deflection or reading, a third for the absolute, and a fourth for the per mile. At the bottom of the sheet spaces may be ruled for the summary of average results, general remarks, date and weather, and name of observer.

The accompanying forms show, first, a full test-sheet for recording the test on a telephone cable, containing fifty-one pairs of wires, that being the type of cable generally adopted by telephone companies using underground systems; and second, a summary of the test for furnishing a report to the executive department, on the general condition of a cable. (Figs. 37 and 38.)

In the heading of the test-sheet are left spaces for the number, description, route and length of the cable. Below this are entered the galvanometer constant and discharge from standard condenser, spaces being left to fill in the number of cells, high resistance and shunt used and the capacity of condenser and battery power employed in taking the discharge. The particulars of the lead are noted here, and in cases where a long lead is used, it would be useful to enter the discharge from the lead before connecting on the cable for capacity test. The rest of the sheet explains itself, the vertical columns being ruled for entering the readings in each test and the results, absolute and per mile, in megohms, microfarads and ohms. The summary at the bottom of the sheet is a useful addition, as it shows at a glance the general condition of the cable. The figures entered in the summary are transferred to the second form, "summary of cable report," when it is necessary to report a test to some department other than that in which the full records are kept. The permanent record book is ruled in an almost precisely similar manner to the test-sheet used for noting down the observations at the time the test is made, with the exception that the summary is transferred to the heading.

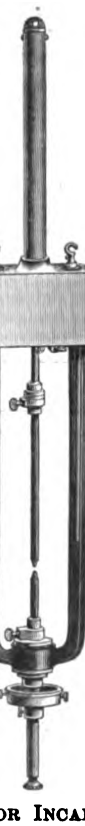
In designing test-sheets for use in cable factories, or for testing single wires, such as electric light cables or overhead wires, the sheet can, of course, be made much smaller, but it will be found a good plan to use a heading, similar to that described above, giving all the details of the cable itself and of the constants used in working out the test, otherwise the records will be incomplete and unsatisfactory.

THE NEW WARD ARC LAMP FOR INCANDESCENT CIRCUITS.

One of the most pronounced features of the present practice of electric lighting and one which is constantly gaining in popularity is the placing of arc lamps on incandescent circuits. While this method of operation was at one time looked upon with distrust, it may be safely said that this was only brought about by the inferiority of the arc lamps at that time available. With the improved construction which has since been brought out, the system has gained rapidly and no better example can be given, not only of its popularity, but also of its economy, than by citing the fact that the Edison Illuminating Company, of Brooklyn, has installed about 625 arc lamps on its incandescent circuits. The lamp here employed is the well-known Ward arc lamp, and a glance at the conditions to be fulfilled and the advantages of operating such lamps is well worthy of consideration.

To begin with, the operation of an arc lamp upon incandescent circuits obviates the necessity of introducing a high tension wire into a building, while on the other hand it offers the great convenience of allowing the arc lamp to be connected to the same circuit as the incandescent lamps for which the building is already wired. This makes the lamp equally well adapted for interior as well as exterior lighting. Again, if we consider the fact that arc lamps placed in circuit with motors are subject to fluctuation, due to the varying work of the motors, the advantages of arc lamps on incandescent circuits are obvious. Although it has been claimed that such an arrangement acts disadvantageously on incandescent lamps, causing unsteadiness and larger breakage, these faults have not been found to exist in installations where the lamp is one that is properly designed, such as that shown in the accompanying illustration. It is evident that both the arc and incandescent lamps, being connected to a constant potential circuit, are practically independent of each other, and that if the potential be maintained constant from the station, there is no good reason why the incandescent lamps should suffer.

The economy of placing arc lamps on incandescent circuits must also be obvious. In the Ward lamp, for instance, which takes 55 volts, two are placed in series across a 110 volt circuit and consume but 8 amperes. These two lamps give an effective illumination equal to 1,600 c. p. each, or 3,200 c. p. The same current, 8 amperes, passing through incandescent lamps would be able to run only 16 lamps of 16 c. p. each, equal to 256 c. p. of illumination. The enormous superiority of the arc light in economy is obvious, and this has been well recognized, especially by the owners of isolated plants. We may mention as instances of this that in the Worthington Pump Works in Brooklyn, alone, 72 of the Ward lamps are in daily operation; 44 at the Grand Central Depot, New York; 56 in the Manhattan Real Estate Association; and 38 in the De la Vergne Manufacturing Company's Works.



Ward Arc Lamp For Incandescent Circuits.

It is obvious that where it is not desired to run two lamps in series, a suitable resistance can be inserted as a compensator. In the new Ward lamp, which is manufactured by the Electric Construction and Supply Co., of this city, a combination feed is employed which operates so that any variation in the current, passing through either of the coils of the lamp, immediately acts to put the controlling mechanism in operation. The lamp is provided with an automatic cut-out, which controls the current perfectly under all conditions, and with a separate switch which renders the trimming of the lamps easy.

New York City.—The Board of Fire Underwriters has extended its thanks to Mr. J. Elliott Smith, the superintendent of the Fire Alarm Telegraphs, and his assistants, for the speedy manner in which the fire alarm telegraph system was restored after the storm of January 25, when so many lines went down all over the city. The Board asks for all the fire telegraph wires to be put underground as soon as possible.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XI. NEW YORK, MARCH 18, 1891. No. 150.

By observation and experiment alone can the mind of man arrive at the knowledge of the laws which rule the universe.—Bacon.

ALTERNATING CURRENTS OF VERY HIGH FREQUENCY.

THE admirable address of Professor Crookes before the London Institution of Electrical Engineers, in which he gave a résumé of his long-continued researches on matter in the so-called "radiant" state, constituted not only a valuable contribution to our knowledge on this subject, but deserves additional recognition from the fact that it has served to call out the work of other explorers in this field, who had thus far remained silent on the subject.

It will be remembered that Prof. Crookes cited as a novel experiment the fact that he had constructed vacuum tubes in which the electrodes were entirely on the exterior, and with which he was nevertheless able to demonstrate the peculiar phenomena noticed in such tubes. It would seem, as above stated, that others have also observed these phenomena, among them being Mr. Nikola Tesla, whose work in this connection requires more than passing notice.

Mr. Tesla, recognizing the fact that the intensity of the effects produced in vacuum tubes, might be considerably enhanced by increasing the frequency of the alternations in the electric impulses, set about the construction of apparatus for this purpose, and after considerable experimenting, succeeded in obtaining a machine giving no less than 30,000 alternations per second. With such a machine at his command, Mr. Tesla experimented on Geissler tubes, and, among other remarkable effects obtained, is one in which an incandescent lamp approached to an induction coil through which currents of such high frequency are passing, lights up and is perceptibly heated. Again, by grasping the lamp by the glass bulb and bringing the metallic terminals near to, or in contact with, a conductor connected to the coil, the carbon is brought to bright incandescence and the glass is rapidly heated.

One of the most remarkable facts in connection with this subject, pointed out by Mr. Tesla, and which has been confirmed by the experiments of Dr. Tatum, with a machine placed at his disposal by Prof. Thomson, as detailed in our last issue, is, that with a 100 volt 10 c. p. lamp, the operator is able to stand without great discomfort a current sufficient to light the lamp brilliantly, thus showing that currents of high frequency are not as dangerous to human life as those ordinarily employed in practice.

Again, Mr. Tesla cites the remarkable effects of placing a condenser in connection with a machine of such high frequency of alternation as he employs. Thus, two bare copper wires of about 20 feet in length and two millimetres in diameter were connected to the terminals of the machine at one end and to a condenser on the other. The electromotive force at the terminals of the condensers was about 120 volts, while at the machine, a distance of only 20 feet, the voltage was only 65.

To explain this phenomenon Mr. Tesla looked for a case of resonance but he finally proved that the capacity which gave the highest E. M. F. corresponded most nearly to that which just counteracted the self-induction with the existing frequency, and any increase or diminution was followed by a fall in the E. M. F. Mr. Tesla concludes from his experience that the condenser may become a very efficient apparatus and capable of transforming considerable amounts of energy. These experiments it will be noted are closely allied to the phenomena observed in connection with the Ferranti mains operated from the Deptford station in London.

Regarding the heating of condensers which takes place when subjected to considerable current of high frequency, Mr. Tesla considers this to be due to three distinct causes: First, leakage or conduction; second, imperfect elasticity in the dielectric; and, third, surging of the charges in the conductor. In utilizing this condenser principle, Mr. Tesla has made incandescent lamps, the end of the filaments being completely sealed in glass, but attached to interior condenser coatings, so that all the energy required must be transferred across the glass with a condenser surface of no more than a few centimetres square. With alternations as high as 15,000 per second it is easy to bring the filaments to incandescence. Unfortunately, however, Mr. Tesla finds that after awhile the glass is perforated by the intense action and the vacuum is thus impaired, but the higher the frequency the longer the lamp holds out. Mr. Tesla points out also that condensers capable of standing a great difference of potential require a dielectric which will involve no losses, and the only perfect one in this respect would be a condenser in which the gas is under pressure; and he has experimented with such a condenser. His experience shows, however, that they are attended with many practical difficulties. In order to make condensers practically useful, higher frequencies would be required, though such a plan, Mr. Tesla points out, has many disadvantages, among them being the fact that they would not be suitable for the operation of motors.

Now that attention has been called to the variety of phenomena which may be observed with currents of such high frequency, the construction of machines for generating them becomes of considerable interest to the electrical engineer. Our readers will, therefore, be interested in the description appearing in another column of several types of machines constructed by Mr. Tesla giving alternations up to as high as 30,000 per second. While, on the surface, the construction of a machine to give a very high number of alternations per second seems a simple enough matter, its carrying out in practice will, upon further examination, be found to involve difficulties of no mean order. Aside from the electrical and magnetic obstacles, which are in themselves sufficient to try the patience of even the most sanguine, the mechanical construction of such a machine, necessarily revolved at enormous speeds, introduces difficulties of a very serious nature.

Mr. Tesla in this issue also continues the discussion on the effect upon arc lamps and arc lamp mechanism of undulating currents, a subject which Prof. Thomson has taken up in his recent communication in our columns.

THE NEW CIRCUIT COURT OF APPEALS.

The act to establish a Circuit Court of Appeals, which was approved by the President on March 3, provides for a Court of Appeals of three Judges, in each judicial circuit, of which two are to constitute a quorum. The Chief Justice of the Supreme Court, the associate justice assigned to each circuit, and the district judges, are competent to sit in the respective circuits. Any judge before whom a case has been originally heard in the district or circuit court is prohibited from sitting at the hearing of the case on appeal. The term of the new court commences the second Monday in January, in the cities of Boston, New York, Philadelphia, Richmond, New Orleans, Cincinnati, Chicago, St. Louis and San Francisco. Appeals from existing district or circuit courts to the supreme court may be taken in cases involving the construction of the Constitution, but in admiralty and patent cases the decision of the circuit court of appeals is final. The circuit courts may, however, certify to the supreme court "any question or proposition of law concerning which it desires the instruction of that court for its proper decision." In any of the classes of cases made final, which includes patent cases, "it shall be competent for the supreme court to require, by *certiorari* or otherwise, any such case to be certified to the supreme court for its review or determination."

Patentees of inventions, owners of patents, and inventors have, we think, abundant cause to congratulate themselves upon the passage of this much needed act. Heretofore, more especially during the past ten years, many of the decisions of the supreme court in patent cases, have been, to say the least, far from satisfactory. Not only have appealed cases been compelled to wait many years for hearing and final determination, but the crowded state of the calendars has rendered it wholly impossible for the justices to bestow upon intricate and complicated questions anything like the amount of consideration necessary to the proper disposition of them, and in fact, many of the opinions themselves are quite sufficient to show that the technicalities of the case could have been but imperfectly understood. The assertion which has often been made, that in cases difficult of comprehension the decision of the supreme court has uniformly been adverse to the patent, does not appear to be altogether without reason. The establishment of the new court will not only insure a much more speedy determination of appealed cases, but a far more careful consideration of the points at issue than has heretofore been possible, and we feel well assured that interests of honest litigants, as well as of abstract justice, cannot but be greatly promoted. Such a result must necessarily have a most favorable effect upon the value of patent property, as well as upon the progress of invention and the development of the electrical arts.

ELECTRIC RAILROADING AND RAILS.

It is perhaps to be regretted that the discussion on Mr. O. T. Crosby's admirable paper read before the Institute did not enter more deeply into the electrical conditions relating to high speed railways, but the direction in which it tended gives unmistakable proof of the fact that electrical engineers are thoroughly aroused to the important question of track construction as an element in the successful operation of electric railways of all kinds. Mr. Crosby pointed out, and Dr. Dudley substantiated in the most thorough manner, the fact, that, for successful high speed railroading, the track must be of such a nature as to offer a minimum resistance to the passage of the train independent of the questions of safety, which would be involved in an inferior track construction at such high speeds. The unreliability of the text-book formulae respecting the coefficients of traction, especially for street railway work, are, we are glad to say, now thoroughly recognized, so that no electrical engineer engaged in this kind of work need be led astray by them any longer. What was pointed out so forcibly as desirable for high speed service is equally applicable to our ordinary electric street car service, and street railway managers are, we believe, already alive to the fact that continuous and successful operation with a minimum of repair can only be secured with a good track.

Backsheesh Again.

The State of New Jersey, under Governor Abbett's administration, seems to be aiming to take the lead in legislation directed to the squeezing of corporations. The taxation bill brought forward at Trenton recently, threatened all New Jersey corporations with an appalling inroad to their treasuries, and now comes assembly bill 348, introduced March 2, by Mr. Trefz, which, if passed, will have serious consequences to all electrical companies in the State. In the 7th and 8th sections authority is conferred upon a State Board to contract with any person or corporation for the construction of subways, and provision is made *that such construction is to be paid for from the rentals received from those using them.* Here is "richness" that might make even a Tammany politician's eyes green with envy. We are informed that the telephone, telegraph and electric lighting companies are taking prompt measures to oppose the bill. Any electric companies in New Jersey that have not already done so will do well to fall into line at once.

EXPERIMENTS WITH ALTERNATING CURRENTS OF HIGH FREQUENCY.

BY

Nikola Tesla

In The Electrical Engineer issue of 11th inst., I find a note of Prof. Elihu Thomson relating to some of my experiments with alternating currents of very high frequency.

Prof. Thomson calls the attention of your readers to the interesting fact that he has performed some experiments in the same line. I was not quite unprepared to hear this, as a letter from him has appeared in the *Electrician* a few months ago, in which he mentions a small alternate current machine which was capable of giving, I believe, 5,000 alternations per second, from which letter it likewise appears that his investigations on that subject are of a more recent date.

Prof. Thomson describes an experiment with a bulb enclosing a carbon filament which was brought to incandescence by the bombardment of the molecules of the residual gas when the bulb was immersed in water "rendered slightly conducting by salt dissolved therein," (?) and a potential of 1,000 volts alternating 5,000 time a second applied to the carbon strip. Similar experiments have, of course, been performed by many experimenters, the only distinctive feature in Prof. Thomson's experiment being the comparatively high rate of alternation. These experiments can also be performed with a steady difference of potential between the water and the carbon strip in which case, of course, conduction through the glass takes place, the difference of potential required being in proportion to the thickness of the glass. With 5,00 alternations per second, conduction still takes place, but the condenser effect is preponderating. It goes, of course, without saying that the heating of the glass in such a case is principally due to the bombardment of the molecules, partly also to leakage or conduction, but it is an undeniable fact that the glass may also be heated merely by the molecular displacement. The interesting feature in my experiments was that a lamp would light up when brought near to an induction coil, and that it could be held in the hand and the filament brought to incandescence.

Experiments of the kind described I have followed up for a long time with some practical objects in view. In connection with the experiment described by Prof. Thomson, it may be of interest to mention a very pretty phenomenon which may be observed with an incandescent lamp If a lamp be immersed in water as far as practicable and the filament and the vessel connected to the terminals of an induction coil operated from a machine such as I have used in my experiments, one may see the dull red filament surrounded by a very luminous globe around which there is a less luminous space. The effect is probably due to reflection, as the globe is sharply defined, but may also be due to a "dark space;" at any rate it is so pretty that it must be seen to be appreciated.

Prof. Thomson has misunderstood my statement about the limit of audition. I was perfectly well aware of the fact that opinions differ widely on this point. Nor was I surprised to find that arcs of about 10,000 impulses per second, emit a sound. My statement "the *curious* point is," etc. was only made in deference to an opinion expressed by Sir William Thomson. There was absolutely no stress laid on the precise number. The popular belief was that something like 10,000 to 20,000 per second, or 20,000 to 40,000, at the utmost was the limit. For my argument this was immaterial. I contended that sounds of an incomparably greater number, that is, many times even the highest number, could be heard if they could be produced with sufficient power. My statement was only speculative, but I have devised means which I think may allow me to learn something definite on that point. I have not the least doubt that it is simply a question of power. A very short arc may be silent with 10,000 per second, but just as soon as it is lengthened it begins to emit a sound. The vibrations are the same in number, but more powerful.

Prof. Thomson states that I am taking as the limit of "audition sounds from 5,000 to 10,000 complete waves per second." There is nothing in my statements from which the above could be inferred, but Prof. Thomson has perhaps not thought that there are two sound vibrations for each complete current wave, the former being independent of the direction of the current.

I am glad to learn that Prof. Thomson agrees with me as to the causes of the persistence of the arc. Theoretical considerations considerable time since have led me to the belief that arcs produced by currents of such high frequency would possess this and other desirable features. One of my objects in this direction has been to produce a practicable small arc. With these currents, for many reasons, much smaller arcs are practicable.

The interpretation by Prof. Thomson of my statements about the arc system leads me *now*, he will pardon me for saying so, to believe that what is most essential to the success of an arc system is a good management. Nevertheless I feel confident of the correctness of the views expressed. The conditions in practice are so manifold that it is impossible for any type of machine to prove best in all the different conditions.

In one case, where the circuit is many miles long, it is desirable to employ the most efficient machine with the least internal resistance; in another case such a machine would not be the best to employ. It will certainly be admitted that a machine of any type must have a greater resistance if intended to operate arc lights than if it is designed to supply incandescent lamps in series. When arc lights are operated and the resistance is small, the lamps are unsteady, unless a type of lamp is employed in which the carbons are separated by a mechanism which has no further influence upon the feed, the feeding being effected by an independent mechanism; but even in this case the resistance must be considerably greater to allow a quiet working of the lamps. Now, if the machine be such as to yield a steady current, there is no way of attaining the desired result except by putting the required resistance somewhere either inside or outside of the machine. The latter is hardly practicable, for the customer may stand a hot machine, but he looks with suspicion upon a hot resistance box. A good automatic regulator of course improves the machine and allows us to reduce the internal resistance to some extent, but not as far as would be desirable. Now, since resistance is loss, we can advantageously replace resistance in the machine by an equivalent impedence. But to produce a great impedence with small ohmic resistance, it is necessary to have self-induction and variation of current, and the greater the self-induction and the rate of change of the current, the greater the impedence may be made, while the ohmic resistance may be very small. It may also be remarked that the impedence of the circuit external to the machine is likewise increased. As regards the increase in ohmic resistance in consequence of the variation of the current, the same is, in the commercial machines now in use, very small. Clearly then a great advantage is gained by providing self induction in the machine circuit and undulating the current, for it is possible to replace a machine which has a resistance of, say, 16 ohms by one which has no more than 2 or 3 ohms, and the lights will work even steadier. It seems to me therefore, that my saying that self-induction is essential to the commercial success of an arc system is justified. What is still more important, such a machine will cost considerably less. But to realize fully the benefits, it is preferable to employ an alternate current machine, as in this case a greater rate of change in the current is obtainable. Just what the ratio of resistance to impedence is in the Brush and Thomson machines is nowhere stated, but I think that it is smaller in the Brush machine, judging from its construction.

As regards the better working of clutch lamps with undulating currents, there is, according to my experience, not the least doubt about it. I have proved it on a variety of lamps to the complete satisfaction not only of myself, but of many others. To see the improvement in the feed due to the jar of the clutch at its best it is desirable to employ a lamp in which an independent clutch mechanism effects the feed, and the release of the rod is independent of the up and down movement. In such a lamp the clutch has a small inertia and is very sensitive to vibration, whereas, if the feed is effected by the up and down movement of the lever carrying the rod, the inertia of the system is so great that it is not affected as much by vibration, especially if, as in many cases, a dash pot is employed. During the year 1885 I perfected such a lamp which was calculated to be operated with undulating currents. With about 1,500 to 1,800 current impulses per minute the feed of this lamp is such that absolutely no movement of the rod can be observed, even if the arc be magnified fifty-fold by means of a lens; whereas, if a steady current is employed, the lamp feeds by small steps. I have, however, demonstrated this feature on other types of lamps, among them being a derived circuit lamp such as Prof. Thomson refers to. I conceived the idea of such a lamp early in 1884, and when my first company was started, this was the first lamp I perfected. It was not until the lamp was ready for manufacture that, on receiving copies of applications from the Patent Office, I learned for the first time, not having had any knowledge of the state of the art in America, that Prof. Thomson had anticipated me and had obtained many patents on this principle, which, of course, greatly disappointed and embarrassed me at that time. I observed the improvement of the feed with undulating currents on that lamp, but I recognized the advantage of providing a light and independent clutch unhampered in its movements. Circumstances did not allow me to carry out at that time some designs of machines I had in mind, and with the existing machines the lamp has worked at a great disadvantage. I cannot agree with Prof. Thomson that small vibrations would benefit a clockwork lamp as much as a clutch lamp; in fact, I think that they do not at all benefit a clockwork lamp.

It would be interesting to learn the opinion of Mr. Charles F. Brush on these points.

Prof. Thomson states that he has run with perfect success clutch lamps "in circuit with coils of such large self-induction that any but very slight fluctuations were wiped out." Surely Prof. Thomson does not mean to say that self-induction wiped out the periodical fluctuations of the current. For this, just the opposite quality, namely, capacity, is required. The self-induction of the coils in this case simply augmented the impedence and prevented the great variations occurring at large time intervals, which take place when the resistance in circuit with the lamps is too small, or even with larger resistance in circuit when the dash pots either in the lamps or elsewhere are too loose.

Prof. Thomson further states that in a lamp in which the feed mechanism is under the control of the derived circuit magnet only, the fluctuations pass through the arc without affecting the magnet to a perceptible degree. It is true that the variations of the resistance of the arc, in consequence of the variations in the current strength, are such as to dampen the fluctuation. Nevertheless, the periodical fluctuations are transmitted through the derived circuit, as one may convince himself easily of, by holding a thin plate of iron against the magnet.

In regard to the physiological effects of the currents I may state that upon reading the memorable lecture of Sir William Thomson, in which he advanced his views on the propagation of the alternate currents through conductors, it instantly occurred to me that currents of high frequencies would be less injurious. I have been looking for a proof that the mode of distribution through the body is the cause of the smaller physiological effects. At times I have thought to have been able to locate the pain in the outer portions of the body, but it is very uncertain. It is most certain, however, that the feeling with currents of very high frequencies is somewhat different from that with low frequencies. I have also noted the enormous importance of one being prepared for the shock or not. If one is prepared, the effect upon the nerves is not nearly as great as when unprepared. With alternations as high as 10,000 per second and upwards, one feels but little pain in the central portion of the body. A remarkable feature of such currents of high tension is that one receives a burn instantly he touches the wire, but beyond that the pain is hardly noticeable.

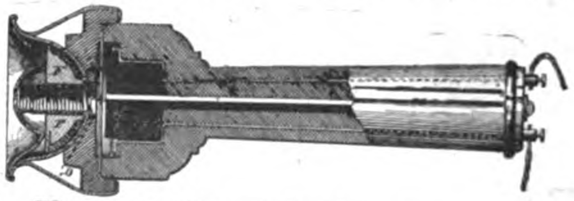
But since the potential difference across the body by a given current through it is very small, the effects can not be very well ascribed to the surface distribution of the current, and the excessively low resistance of the body to such rapidly varying currents speak rather for a condenser action.

In regard to the suggestion of Dr. Tatum, which Prof. Thomson mentions in another article in the same issue, I would state that I have constructed machines up to 480 poles, from which it is possible to obtain about 30,000 alternations per second, and perhaps more. I have also designed types of machines in which the field would revolve in an opposite direction to the armature, by which means it would be possible to obtain from a similar machine 60,000 alternations per second or more.

I highly value the appreciation of Prof. Thomson of my work, but I must confess that in his conclusion he makes a most astounding statement as to the motives of his critical remarks. I have never for a moment thought that his remarks would be dictated by anything but friendly motives. Often we are forced in daily life to represent opposing interests or opinions, but surely in the higher aims the feelings of friendship and mutual consideration should not be affected by such things as these.

WRIGHT AND WILSON'S INDUCTION PREVENTER FOR TELEPHONES.

THE accompanying illustration represents a device for which the inventors, Messrs. Thomas F. Wright and Ed. G. Wilson, of Chicago, claim prevents the disturbing effects of induction. The device is intended for attachment to the ordinary receivers now in use, and consists of a casing of sheet metal, having the external appearance of a small cup which fits snugly within the concavity in the end of the receiver, the interior being concaved around the edges of the cup and provided with a central projecting dome intended to fit against and within the ear.



WRIGHT AND WILSON'S INDUCTION PREVENTER.

The two walls of the casing are provided with central perforations C D, between which a passage is formed by the insertion of a tube E composed of a coil of small steel wire. Surrounding this tube, but enclosed within the casing, is a spool F, grooved externally, as shown, and wound with a coil of fine copper wire, one end of which is driven into the spool, while the free end terminates immediately in front of, but out of contact with, the diaphragm of the telephone-receiver.

This induction-preventing device is attached to the receiver by the spring hook attached to the casing which engages the usual flange upon the end of the receiver.

TESLA'S ALTERNATING GENERATORS FOR HIGH FREQUENCY.

It has now become a common practice to run arc lamps by alternating or pulsating, as distinguished from continuous, currents; but an objection which has been raised to such systems exists in the fact that the arcs emit a pronounced sound, varying with the rate of the alternations or pulsations of current, for which, up to the present, no effective remedy has been found. This noise is due to the rapidly alternating heating and cooling, and consequent expansion and contraction, of the gaseous matter forming the arc which corresponds with the periods or impulses of the current. Another disadvantageous feature is found in the difficulty of maintaining an alternating current arc in consequence of the periodical increase in resistance corresponding to the periodical working of the current. This feature entails a further disadvantage, namely, that small arcs are impracticable.

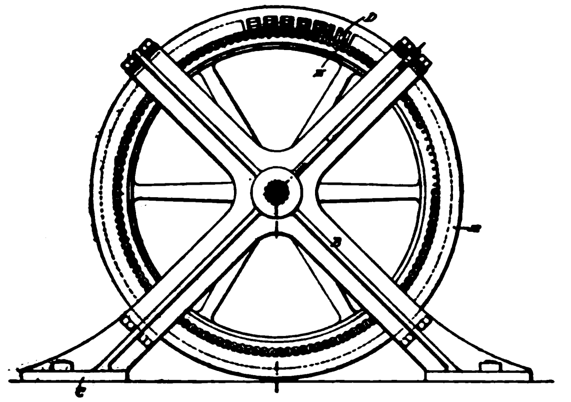
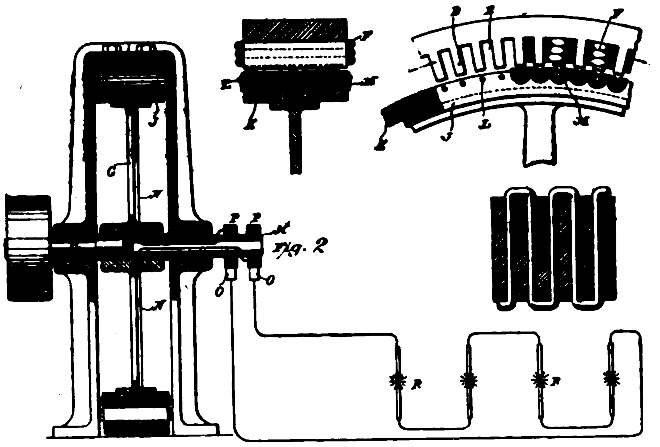


Fig. 1.—Tesla High Frequency Alternating Generator.

Theorectical considerations have led Mr. Tesla to the belief that these disadvantageous features could be obviated by employing currents of a sufficiently high number of alternations and his anticipations have been confirmed in practice. These rapidly alternating currents render it possible to maintain small arcs which, besides, possess the advantages of silence and persistency. The latter quality is due to the necessarily rapid alternations, in consequence of which the arc has no time to cool, and is always maintained at a high temperature and low resistance.



Figs. 2, 3, 4, 5.—Tesla High Frequency Alternating Generator.

At the outset of his experiments Mr. Tesla encountered great difficulties in the construction of these machines. A generator of this kind is described here, which, though constructed quite some time ago, is well worthy of a detailed description.

In the accompanying engravings, Figs. 1 and 2 show the the machine, respectively, in side elevation and vertical cross-section; Figs. 3, 4 and 5 showing enlarged details of construction. As will be seen, A is an annular magnetic frame, the interior of which is provided with a large number of pole-pieces D.

Owing to the very large number and small size of the poles and the spaces between them, the field coils are applied by winding an insulated conductor F zigzag through the grooves, as shown in Fig. 5, carrying the wire around the annulus to form as many layers as is desired. In this way the pole-pieces D will be energized with alternately opposite polarity around the entire ring.

For the armature, Mr. Tesla employs a spider carrying a ring J, turned down, except at its edges, to form a trough-like receptacle for a mass of fine annealed iron wires K, which are wound in the groove to form the core proper for the armature-coils. Pins L are set in the sides of the ring J, and the coils M are wound over the periphery of the armature-structure and around the pins. The coils M are connected together in series, and these terminals N carried through the hollow shaft H to contact-rings P P, from whence the currents are taken off by brushes O.

In this way a machine with a very large number of poles may be constructed. It is easy, for instance, to obtain in this manner three hundred and seventy-five to four hundred poles in a machine that may be safely driven at a speed of fifteen hundred or sixteen hundred revolutions per minute, which will produce ten thousand or eleven thousand alternations of current per second. Arc lamps R R are shown in diagram as connected up in series with the machine in Fig. 2. If such a current be applied to running arc lamps, the sound produced by or in the arc becomes practically inaudible, for, by increasing the rate of change in the current, and consequently, the number of vibrations per unit of time of the gaseous material of the arc up to, or beyond, ten thousand or eleven thousand per second, or to what is regarded as the limit of audition, the sound due to such vibrations will not be audible. The exact number of changes or undulations necessary to produce this result will vary somewhat according to the size of the arc—that is to say, the smaller the arc the greater the number of changes that will be required to render it inaudible within certain limits. It should also be stated that the arc should not exceed a certain length.

The difficulties encountered in the construction of these machines are of a mechanical as well as an electrical nature. The machine may be designed on two plans: the field may be formed either of alternating poles, or of polar projections of the same polarity. Up to about 15,000 alternations per second in an experimental machine, the former plan may be followed, but a more efficient machine is obtained on the second plan.

In the machine above described, which was capable of running two arcs of normal candle power, the field was composed of a ring of wrought iron 32 inches outside diameter, and about one inch thick. The inside diameter was 30 inches. There were 384 polar projections. The wire was wound in zigzag form, but two wires were wound so as to completely envelop the projections. The distance between the projections is about $\frac{3}{16}$ inch, and they are a little over $\frac{1}{16}$ inch thick. The field magnet was made relatively small so as to adapt the machine for a constant current. There are 384 coils connected in two series. It was found impracticable to use any wire much thicker than No. 26 B. and S. gauge, on account of the local effects. In such a machine the clearance should be as small as possible; for this reason the machine was made only 1½ inch wide, so that the binding wires might be obviated. The armature wires must be wound with great care as they are apt to fly off in consequence of the great peripheral speed. In various experiments this machine has been run as high as 3,000 revolutions per minute. Owing to the great speed it was possible to obtain as high as 10 amperes out of the machine. The electromotive force was regulated by means of an adjustable condenser within very wide limits, the limits being the greater, the greater the speed. This machine was frequently used to run Mr. Tesla's shop lights.

The machine above described was only one of many other types constructed. It serves well for an experimental machine, but if still higher alternations are required and higher efficiency is necessary, then a machine on a plan described in Figs. 6 to 9, is preferable. The principal advantage of this type of machine is that there is not much magnetic leakage, and that a field may be produced, varying greatly in intensity in places not much distant from each other.

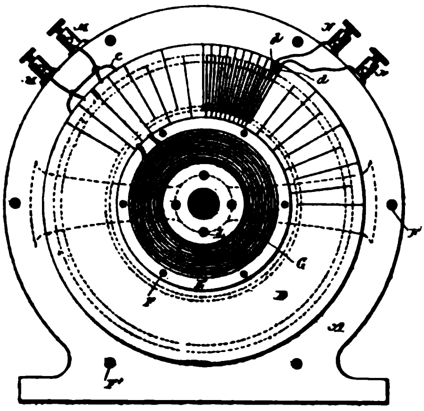


FIG. 6.—TESLA HIGH FREQUENCY ALTERNATING GENERATOR.

In these engravings, Figs. 6 and 7 illustrate a machine in which the armature conductor and field coils are stationary, while the field magnet core revolves. Fig. 8 shows a machine embodying the same plan of construction, but having a stationary field magnet and rotary armature.

The conductor in which the currents are induced may be arranged in various ways; but Mr. Tesla prefers the following method: He employs an annular plate of copper D, and by means of a saw cuts in it radial slots from one edge nearly through to the other, beginning alternately from opposite edges. In this way a continuous zigzag conductor is formed. When the polar projections are $\frac{1}{8}$ inch wide, the width of the conductor should not, under any circumstances, be more than $\frac{1}{32}$ inch wide; even then the eddy effect is considerable.

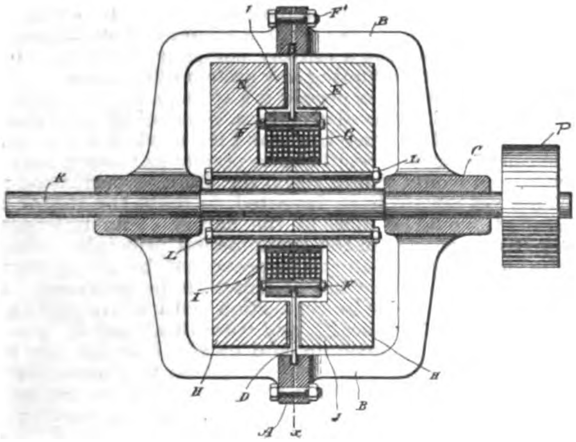


FIG 7.—TESLA HIGH FREQUENCY ALTERNATING GENERATOR.

To the inner edge of this plate are secured two rings of non-magnetic metal E, which are insulated from the copper conductor, but held firmly thereto by means of the bolts F. Within the rings E is then placed an annular coil G, which is the energizing coil for the field magnet. The conductor D and the parts attached thereto are supported by means of the cylindrical shell or casting A A, the two parts of which are brought together and clamped to the outer edge of the conductor D.

The core for the field magnet is built up of two circular parts H H, formed with annular grooves I, which, when the two parts are brought together, form a space for the reception of the energizing coil G. The hubs of the cores are trued off, so as to fit closely against one another, while the outer portions or flanges which form the polar faces J J, are reduced somewhat in thickness to make room for the conductor D, and are serrated on their faces. The number of serrations in the polar faces is arbitrary; but there must exist between them and the radial portions of the conductor D a certain relation, which will be understood by reference to Fig. 9, in which N N represent the projections or points on one face of the core of the field, and S S the points of the other face. The conductor D, is shown in this figure in section a a' designating the radial portions of the conductor, and b the insulating divisions between the same. The relative width of the parts a a' and the space between any two adjacent points N N or S S is such that when the radial portions a of the conductor are passing between the opposite points N S, where the field is strongest, the intermediate radial portions a' are passing through the widest spaces midway between such points and where the field is weakest. Since the core on one side is of opposite polarity to the part facing it, all the projections of one polar face will be of opposite polarity to those of the other face. Hence, although the space between any two adjacent points on the same face may be extremely small, there will be no leakage of the magnetic lines between any two points of the same name, but the lines of force will pass across from one set of points to the other. The construction followed obviates to a great degree the distortion of the magnetic lines by the action of the current in the conductor D, in which it willl be observed the current is flowing at any given time from the centre toward the periphery in one set of radial parts a and in the opposite direction in the adjacent parts a'.

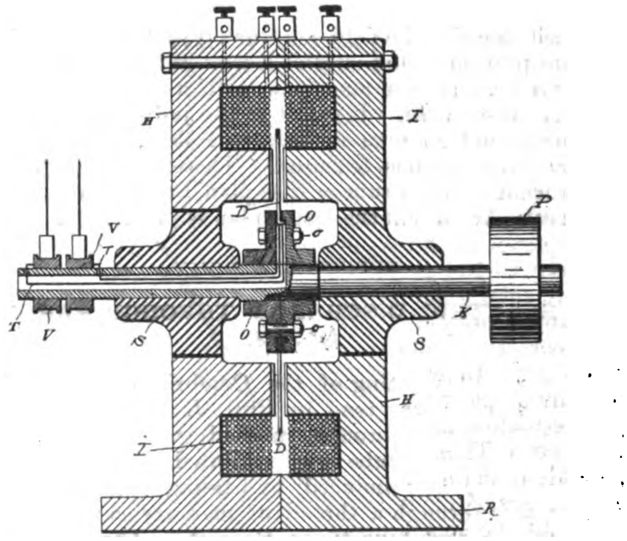


FIG. 8.—TESLA HIGH FREQUENCY ALTERNATING GENERATOR.

In order to connect the energizing coil G with a source of continuous current, Mr. Tesla utilizes two adjacent radial portions of the conductor D for connecting the terminals of the coil G with two binding posts M. For this purpose the plate D is cut entirely through, as shown, and the break thus made is bridged over by a short conductor C. The plate D is cut through to form two terminals d, which are connected to binding posts N. The core H H, when rotated by the driving pulley, generates in the conductors D an alternating current, which is taken off from the binding posts N.

When it is desired to rotate the conductor between the faces of a stationary field-magnet, the construction shown in Fig. 8 is adopted. The conductor D in this case is made in substantially the same manner as above described by slotting an annular conducting-plate. The field-magnet in this case consists of two annular parts H H, provided with annular grooves I for the reception of the coils. The flanges surrounding the annular groove are brought together, while the inner flanges are serrated, as in the previous case, and form the polar faces.

In a type of machine of this kind, constructed by Mr. Tesla, the field had 480 polar projections on each side, and from this machine it was possible to obtain 30,000 alternations per second. As the polar projections must necessarily be very narrow, very thin wires or sheets must be used to avoid the eddy current effects. Mr. Tesla has thus constructed machines with a stationary armature and rotating field, in which case also the field-coil was supported so that the revolving part consisted only of a wrought iron body devoid of any wire, and also machines with a rotating armature and stationery field. It is left to the judgment of the experimenter which plan is best to follow, each promising certain advantageous features. These machines may be constructed on the drum or disc plan, but the experience of Mr. Tesla shows that the latter plan is preferable.

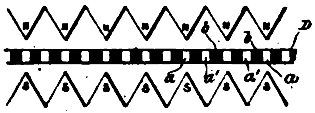


FIG. 9.—TESLA HIGH FREQUENCY ALTERNATING GENERATOR.

THE ELECTRIC DISCHARGE THROUGH RAREFIED GASES.

At a recent meeting of the Cambridge Philosophical Society, a paper was read by Prof. J. J. Thomson on the electric discharge through rarefied gases without electrodes. A vacuum tube was exhibited, in which an electric discharge was induced by passing the discharge of Leyden jars through a thread of mercury contained in a glass tube coiled four times along it. The induced discharged was found to be confined to the part of the vacuum tube which was close to the primary discharge, and it did not show striæ. It was also demonstrated that an ordinary striated discharge is strikingly impeded by the presence of a strong field of magnetic force.

ELECTROSTATIC MEASURING INSTRUMENTS.

THERE would seem to be, says *Industries*, some kind of prejudice against the use of electrostatic measuring instruments. Generally, in an alternating-current station, we find the high-pressure leads connected to transformers reducing to 100 volts or so, and a hot-wire voltmeter employed to read by. The transformer takes, say, 30 watts, probably more, and the voltmeter another 30. This means 500 kilowatt hours per annum wasted. At 5 cents this comes to $25 a year, which is the interest on from $250 to $500. A laboratory electrometer was used in electric engineering by Joubert in 1881, and others have been used occasionally since by Profs. Ayrton and Perry, Ryan and Monnier. Sir William Thomson has, however, introduced a number of electrostatic instruments, reading from 100 volts upwards, and engineers who use them do not revert to electro-magnetic or hot-wire voltmeters. Electrostatic instruments not only take no power, but have no temperature errors, and do not need corrections for frequency, and no doubt they will eventually be cheaper than other forms.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER *150 Broadway, New York city.*

THE QUESTION OF RAILWAY MOTOR GUARANTEES.

I have read with no little interest an article in your last issue, entitled "Electric Railway Guarantees," by A. H. Chadbourne, which is, in effect, an attempt to apologize for the short life of an armature by showing the unreliability of the men who supervise its use. Mr. Chadbourne is unquestionably right. If the electrical world had men who would nurse an armature, as its short life requires that it should be, there is no doubt whatever that its numbered days would be somewhat lengthened. Such a procedure is proportionately true of almost anything used in connection with machinery; true of nearly everything that exists. As Mr. Chadbourne correctly states, the refusal of a company to guarantee its motor is a "sticker," and one that will always "stick" until some one has invented an armature that will not be open to such an objection as is prompted by the inquiry. The strongest point made by Mr. Chadbourne lies in the statement that a company should "First guarantee the superintendent before we guarantee our machinery." Everyone knows that in all walks of life, whether it is in art, mercantile life, manufacturing, railroad, finance, marine, governmental, artisan, or what not, the *experts* are few; the *good* men not galore; the *medium* men in very much lesser number than the "good," and the poor, indifferent fellows in distressing majority. This is historically true, and the situation is not remedied by giving us a *weakling* to be taken care of by a *poor* nurse.

It is because companies cannot rely upon men to do their duty, that an armature is needed that will not require any more than casual attention.

In the present state of mind that is anxiously watching for developments in the electrical field, there is undoubtedly not so much a seeming want of faith in what has been invented as a fear that the adoption of a certain system may preclude the adoption of something better that may spring up suddenly like a jack in a box. This is a natural fear and is much augmented by the fact that a change of systems on a horse, or other, railway means the expenditure of a great deal of money, as well as involving no end of trouble, etc. It is, therefore, not to be wondered at that a railway company should hesitate before awarding a contract that would involve so much to them.

An armature of which there is any doubt at all, should not be considered seriously by any railway company, no matter how many careful superintendents and attentive men they may have on hand to supervise its working. In a matter of such importance, *doubt* should not exist and a railway company would not be doing justice to itself by adopting any system other than a reasonably perfect one. What is needed is a storage battery motor car that is safe with a long-lived armature, economical and durable, and such a one will, in time, command the market of the railway world, simply because it would be as perfect as human invention can devise, and would almost reach the limit of perfection; and what would yet remain to be invented, to make the motor absolutely perfect, would be more in the nature of an unimportant auxiliary than a change in the fundamental principle. An armature, the burning of which can be prevented by the application of a perfectly devised mechanical clutch, *is in existence.* Such an armature is now used in connection with a storage battery that is "safe" "economical" and "durable," and if you will pardon me (as I am the inventor and owner) I would say that I am reasonably sure that the desideratum is now furnished, the confirmation of which claim is in the fact that a severe test has been repeatedly made for seven months, day and night; in all kinds of weather, varying and annoying grades, and in short under all such trying conditions as have forced the severest possible test that can be had, with a view to arriving at a practical and common-sense result.

Arrangements are now making for the presentation of my system to the railway market, and, if Mr. Chadbourne will only exercise a little patience, he will not be harrassed nor worried in an attempt to unstick the "sticker" that is being so successfully stuck into him and others interested in the subject.

J. F. M'LAUGHLIN.

PHILADELPHIA, March 12, 1891.

PROF. A. G. BELL has given $25,000 to the Association for the Teaching of Speech to the Dumb, of New York.

THE INVENTIONS OF THOMAS DAVENPORT.[1]

BY FRANKLIN L. POPE.

THE year 1837 marked a very important era in the history of the industrial development of electricity. During that year, two of the most extraordinary inventions of the present century made their advent in this city—the electric telegraph of Prof. Samuel F. B. Morse, and the electric motor of Thomas Davenport. The motor came first. Davenport, a self-taught Vermont blacksmith, who had invented and constructed his machine in a remote country village in a crude form as early as 1834, came to New York in February, 1837, bringing with him some of the machinery which had been made for the purpose of exhibition, by himself and Ransom Cook, with a view to enlisting capital to build a large motor. During the season of 1837 he occupied rooms in the city where he exhibited models of his motor and various other electrical inventions. Articles were published in the newspapers of the day, and his exhibitions were attended by a great number of people. In letters written about that time, Davenport mentioned that one of the most frequent visitors was Professor Morse.

With the history of Professor Morse and his inventions of the telegraph the world is quite familiar. With the history of Davenport and of the invention of his electric motor—as I soon discovered in endeavoring to obtain information about it myself—scarcely anything was known. This difficulty ultimately led me to interest myself in trying to find out more about the matter. In this undertaking I was fortunately very much more successful than one can reasonably expect to be, in attempting to resuscitate the history of an invention which has lain unknown for the best half of a century.

The first newspaper notice of the electric telegraph which appeared in America was in the *New York Observer* in the summer of 1837. I will read you an extract from it:

"A gentleman of our acquaintance several years since suggested that any intelligence might be communicated almost instantaneously hundreds, if not thousands of miles, by means of very fine wires, properly coated to protect them from moisture and extending between places thus widely separated. It is well known that the electric fluid occupies no perceptible time in passing many miles on a wire, and if it is possible by connecting one end of the wire with an electrical or galvanic battery to produce *any sensible effect whatever* at the other, it is obvious that if there are twenty-four wires, each representing a letter of the alphabet, they may be connected with the battery successively in any order, and if so connected in the order of the letters of any word or sentence, that word or sentence could be read or written by a person standing at the other end of the wires. All the paragraphs of a newspaper could thus be touched by a man in Philadelphia, and the contents, *verbatim et literatim* conveyed to New York as fast as a compositor could set up the type!"

It has always been a mystery to me what invention was referred to in that article. *The New York Observer* was edited at that time by a brother of Professor Morse. The "gentleman of our acquaintance" referred to, was no doubt Professor Morse, but what was meant by the telegraph of twenty-four wires I could never make out, because we all know that Morse never entertained any idea other than that of a single-circuit telegraph at any time from the beginning of his experiments in 1835, or earlier. But I received a few days since a letter from a gentleman who had read some articles recently published by me in reference to Davenport's work,[2] in which he stated that he visited Davenport's exhibition in the summer of 1837, here in the city of New York, and that he himself saw in that exhibition a model of a telegraph of twenty-four wires invented by Davenport, and that model must undoubtedly be the telegraph referred to in the extract I have just read.

In pursuing my investigations into the history of Davenport's work, I was fortunate enough to find that several of his original models were still in existence. One of these models, a circular railway two feet and a half in diameter with a locomotive traveling on it, similar to the one which we have here to-night but very much more finely finished, I was able to satisfy myself by contemporaneous evidence was built in 1837. The one which is before you was found in the cabinet of the Female Seminary in Troy, formerly Miss Willard's. The records of the institution show that it was purchased in 1840, but it evidently must have been built by Davenport himself prior to the more finely finished model of which I have just spoken, which was constructed in 1836-7 with the assistance of Mr. Ransom Cook, of Saratoga, a very ingenious person and a finished mechanic. I think there is no doubt that the model before us was built in the early part of 1837 and possibly as early as 1836. Fortunately it is, as you see, in a very good state of preservation. I have had it mounted to-night with the same battery that was found with it—a three-cell Grove battery of pint cups, and I think we shall find that it is in tolerably fair running order. [The model was set in motion.] It does not go quite a hundred and twenty miles an hour, but it goes. This locomotive, you will observe, has a fixed field magnet below, and a revolving armature above, which is reversed twice in every revolution. So far as I am able to discover, that is a combination found in every practical motor to-day, which Davenport was the first to make known and to use in 1834. The motor is connected to the driving axle by bevel-gear. The field and armature in the model before you are connected in series. In the other model of 1837 of which I spoke, they are connected *in shunt*. Among other models of Davenport was one having a horse-shoe field and a four-pole armature with curved pole-pieces, which is really quite an advanced type of motor. That also was built in 1837. Altogether, Davenport, between 1834 and 1840, built over 100 motors of different patterns and of varying sizes, scarcely any two of them alike. I discovered also, quite to my surprise, that he was undoubtedly the first to make use of the solenoid with a movable core, as a means of moving machinery of any kind. He built in 1839 quite a large motor operating upon that principle, which from the best description I have been able to find of it, must have approached one horse power. He set that up at 42 Stanton street, in New York; attached a printing press to it and started to publish the pioneer electrical journal of America—a small weekly paper called "The Electro-Magnet and Mechanics' Intelligencer," printed by electrical power. Through the kindness of Mr. Davenport's son, Rev. Willard G. Davenport, I have the pleasure, on his behalf, of presenting to the American Institute of Electrical Engineers two copies of that paper. [Applause.] These, so far as is known, are the only editions ever published; they are number one and number two. This was in 1840. I have received within a day or two an interesting letter from Mr. H. S. Davenport, a nephew of Thomas Davenport, still living in Vermont at an advanced age, who, as a boy, was with him a great deal and in that way became quite familiar with his work. I will take the liberty of reading extracts which give some idea of the manner of man Mr. Davenport was. He says:—

"Many of his models never left his shop and were but little known even at the time of their construction. They were only made to show to how many uses the power could be applied, and also to work from on a larger scale, if he could get pecuniary aid to do so. The different models which interested me most, at the several times I was in his shop, were a trip-hammer, a turning lathe and a machine for doubling, twisting and reeling cotton or silk, all at the same time. A circular frame fitted with two intersecting tracks, on which four miniature cork images glided around, he called his "puppet-show." He was naturally of a retiring disposition, but when waked up was very strong in argument. His two favorite subjects were nature and electro-magnetism. He considered magnetism the most important element in the creation of the universe and thought it would be in its destruction. Magnetism kept the heavenly bodies in their places, and if that failed everything would be turned to chaos. He could see in every rock of the earth the battery of which it was composed. So also in the animal kingdom, the bones, muscles, and blood constituted a complete battery, which exercised a repulsive or attractive force with respect to another organism of the same kind. He was a great lover of fun and exceedingly fond of a joke. On one occasion he received an order from a party in Chicago for half-a-dozen bottles of electricity. He said he knew by the tenor of the letter that it was intended as a joke, and he accordingly replied that he bottled up his *wrath* for such would-be ignoramuses as he was, but had no electricity for him."

I might go on and relate many other facts of interest which I have learned about Mr. Davenport and his inventions, but the hour is already late, and I will forbear. But I may remark in conclusion, that I find him to have been one of the most interesting characters with whom I have ever become acquainted, and I cannot but feel highly gratified that my attention chanced to be directed to the subject, in season to rescue at least some of the more important of his work from impending oblivion. In two or three years more it would have been too late. There are people now living, although at an advanced age, who knew him and remember him perfectly, but in a year or two more perchance they will be gone. [Applause.]

ELECTRIC LIGHTING AT TUSSAUD'S WAX WORKS.

A correspondent of the London *Electrician* states that at Madame Tussaud's wax works exhibition, a single arc lamp has displaced 500 gas jets for illuminating the entrance hall and grand staircase.

MR. ALLAN V. GARRATT.

The above named gentleman, who is well-known in electrical circles, went West recently to establish himself, and has now opened offices as an electrical engineer and contractor at Spokane Falls, Wash. He is already actively at work there, and has now organized the Spokane and University Heights Street Railway Co., of Spokane Falls, which will build and equip 6 miles of electric road in the spring. The officers of the company are: Allan V. Garratt, president and general manager; Robert Abernethy, vice-president; and L. B. Cornell, secretary.

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[1] Read before the American Institute of Electrical Engineers, February 24, 1891.

[2] See THE ELECTRICAL ENGINEER, Jan. 7, *et. seq.*

INSTITUTE DISCUSSION ON HIGH-SPEED ELECTRIC RAILWAY WORK.

The following is an abstract of the discussion of Mr. O. T. Crosby's paper entitled "Report of High-Speed Electric Railway Work" read before the American Institute of Electrical Engineers on Feb. 24, 1891.

Mr. W. H. Pierce inquired if Mr. Crosby had made any calculations or estimates as to how far and how long the train would run before it would attain a speed of 150 miles, and how far it would have to run before it could be stopped.

Mr. Crosby replied that the space for stopping, with a braking power that would just fail to slide the wheels, would be just about 7,000 feet and the time would be in the neighborhood of 100 seconds. The time of getting the train to speed with the motors as designed, is in the neighborhood of two or three miles.

Mr. Crosby :—I should say that I do not think there is anything whatever in high-speed work for, say, even forty miles. I do not think you can properly do 120 miles an hour for a run of say thirty or forty miles. It is applicable only to connecting very large cities. I think you could run from here to Albany, if you had the New York Central line to run on; from Albany to Rochester, from Rochester to Buffalo, and then stopping at the principal lake cities. It might be found later on that it would be necessary to make shorter stops, but the first effort should be made only with very long runs.

Mr. F. L. Pope :—In conversation some time ago with a prominent civil engineer, at one time professionally connected with the Lake Shore road, he expressed the opinion that safety from derailment at very high speeds would be best secured by very slightly curving the line of the road just sufficient to cause the flanges of the wheels to bear constantly against one side. With that construction he should expect that any possible speed, up to, say, 200 miles an hour, that could be got from the motors, would be perfectly safe. He was led to this conclusion from long observation of the performances on the Lake Shore road of railroad wheels at high speed, on which road some of the best running in this country has been done.

Mr. Thomas D. Lockwood remarked that the best speed he had ever known to be made out of an average of a great many trips had been done by way trains where the stations were very close together, and the reason of that is, that upon a long run you can obtain a fairly high average without even getting an immensely high speed, whereas upon way trains, where the stations are very frequent, we often have to run at enormously high speed between stations to maintain the time, and that is often when we have runs of only two miles between stops. He also inquired whether Mr. Crosby had any decided opinion on the value of the method of increasing traction by means of passing a current between wheel and rail.

Mr. Crosby, as the result of his experiments, did not think that the method possessed any value. He knew of experiments which were never published but which were made by a man much interested in the subject at one of the great universities of the country which indicate that in a three or four pound model it took something like two hundred amperes to produce any effect, and that was plainly a welding effect, since it showed a clear pitting of the little rail on which this model used to run.

He did not consider the matter of return of energy to the line, because they wanted all the power they could get, and because the number of stops was very small compared with the number of miles run. It might be different, say, on the elevated railway service. It might do to run the motors as dynamos and let them give back the work of retardation into the line. But you make a little sacrifice to do that. That is, you have got to work your motors at lower than saturation point for your normal work. Otherwise he did not see how one can get the electromotive force of the motor high enough to pump back into the line. For that reason he did not think it had any place in long distance work where the stops are one in a hundred miles. In answer to a question of Mr. Pierce, Mr. Crosby said that he assumed thirty-three per cent. drop on the line, and had done so all along, thinking that it would be practicable to have that; although he did not know that it would be the most economical drop, not having calculated.

Mr. Edward P. Thompson inquired whether it were practicable to run an automatic electric train for the purpose of carrying mail matter and other objects of great value where it is necessary to have high speed? As regards brakes for stopping high-speed trains, the principal point is economy. He found in some tests he had made in behalf of a brake company upon a railway in Pennsylvania, that if it needs a certain amount of energy to start a train, it needs about nine-tenths as much to make an emergency stop. In local or accommodation trains the expense would be enormous, therefore, to so frequently reduce the speed as soon as it reached 120 miles an hour, if the electric current were used as the braking power. In the experiments referred to, the momentum of the train was used for braking, while the electric current was merely the agent for controlling the application of the force of momentum. This force is very cheap and plentiful, and even with the crude apparatus employed, emergency stops were made in which the cost was simply that of an electric current of two amperes acting for less than one second.

Mr. Crosby :—In order to have any kind of service, whether you try it automatically or not, you have got to have it safe enough for a man to be on the car. That is, you must not have so many accidents as would make it unsafe for a man to go on there, or your business would be gone. If you have an engineer he can have a man to sit by him and another man by him, and you go on till finally you have a passenger train. [Laughter.] I do not consider it practicable to run a train that is of any size, enough to make it commercial, without a man on it. I think the enormous complexity of an automatic system that would take care of the entrance into a city and the departure from a city and of all the varying conditions of service, without a man on board, is really beyond anything that would stand up. You might put it all down to work and have trains on it, but I think the complexity would soon break it down. I think the limitation, so far as steam railways are concerned, is the ability of the engine to draw enough cars to accommodate people who want to go at that speed. That is what the New York Central people claim in regard to their limited train to Chicago. They cannot run any more cars and have their engines make the speed that is wanted. People at Buffalo complain that they cannot get the fast service which people going from here to Chicago get. They have wanted additional cars put on, and the railway company has answered, We cannot put on additional cars without sacrificing what we are aiming at, which is high speed.

Dr. P. H. Dudley :—I have made experiments on the resistance of different trains. Those were made several years ago and not on as good tracks as we have at the present time. The resistance of the passenger train is given by the formulæ in books, as seventeen or eighteen pounds per ton. I found on the Lake Shore Michigan Southern Railway and the New York Central & Hudson River Railroad that with trains of about 250 tons the resistance was only from ten to twelve pounds per ton at speeds of from fifty to sixty miles per hour. The resistance per ton is not nearly so great on those long trains, as on the short ones. With trains of two and three cars, sometimes it ran as high as thirty-five or forty pounds per ton, but with long trains it ran down to about ten and twelve pounds per ton.

The greatest variable that we find from day to day over the same track and same train is the wind resistance. I found in one special experiment I made in 1878 to see why the New York Central was not able to make its time with its trains, that on a still day, with the schedules they had, they were able to make time, but a wind of ten or twelve miles would retard the trains so that in running from Buffalo to New York they would loose two hours. The trouble at that time was that the boilers were not large enough to quickly generate the steam required to meet the increased resistance. The trains would run up to a speed just about the capacity of the boiler and that would limit the speed they could maintain. Therefore when a head or side wind was blowing against them, the speed of the train would be reduced very materially.

One gentleman spoke about the fast speed of the local passenger trains. The fastest speed usually found on trains is in the local passenger service, for five to twenty seconds—especially those stopping every two or three miles. They often attain a speed for a few seconds as high as fifty-five or sixty miles per hour. Then they shut off steam and apply the brakes to stop the train. The heavy trains of eight to ten cars, running long distances, rarely attain sixty miles an hour, that is on the ordinary schedules.

The greatest improvement that has been made in decreasing train resistance is in the improvement of the track by bringing up the standard of excellence and adoption of heavier and stiffer rails. I have been making a number of heavy rail sections for different railroads, and instead of making them simply heavy, I had made them very stiff, which has reduced the deflection or wave motion under each of the wheels. Comparing the resistance of the Chicago Limited Express on stiff eighty pound rails, with that of sixty-five pound rails which have been on the track some time, it makes a difference of seventy-five to one-hundred horse power per mile. I have just made some ninety-five pound rails for a road, which will be very much stiffer than the eighty pound rails. We find now that the condition in which they are keeping the line is so perfect that there is scarcely any oscillation on the best roads, and there is very little difference in the oscillation now in riding on a tangent or a curve. I should prefer a tangent for smooth riding, although the wheels press against the rails on curves. Unless they are properly elevated, there will be some oscillation, though our present trains move very steadily on the best tracks. I have made careful experiments, and with a track in good condition the heavy cars ride very steadily, leaving little to be desired.

Mr. C. O. Mailloux :—I found that the ordinary data in relation to the traction on street railroads are entirely unreliable. Various estimates have been given by civil engineers and others for the electrical traction per ton for a street car. The most authentic figures placed the traction at something like 18 pounds per ton. In practice, as the result of the crude traction-dynamometer experiments just mentioned, I have found the traction below twenty pounds with a car having a considerable weight. I have found that the traction per ton reached in some cases over thirty pounds and it has gone as high as forty pounds. Calculating the traction theoretically, using the coefficient of friction on the axle, the weight and the well-known formula (since the power exerted is expended practically in overcoming the friction of the axles), one would expect to find a much lower traction. As a matter of fact, calculation gives a figure which is nearly in accordance with the data given by the engineers; yet practice always gives a higher figure by fifty per cent. and often more. I concluded from this that as the car is being continually lifted slightly we must introduce into the formula for traction a factor which is a function of the weight of the car itself; in other words, that the traction per ton increases with the weight of the car. I mean that the traction per ton for a car weighing three tons might be twenty or twenty-five pounds, while that of a car weighing seven or eight tons under the same circumstances might be probably thirty or thirty-five pounds. This view might explain the lower figures found for the traction of horse cars, these being of so much smaller weight. I would like to ask Mr. Crosby in regard to the initial torque; that is, the amount of traction which is necessary to overcome static friction; in other words, what he finds the difference between static and kinetic friction to be. I have found in my experience that the initial traction went up as high 80 to 100 pounds per ton.

Mr. Geo. B. Prescott, Jr., confirmed what Mr. Mailloux said about the unreliability of the traction figures for street cars that are given in some text books. In experiments he had made in Boston he had found that on a perfect level the traction to be somewhere in the neighborhood of 30 pounds to the ton for a car weighing about six tons.

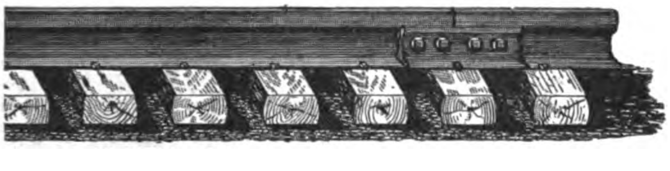


Fig. 1.—Rail in Good Condition.

Dr. Wm. E. Geyer inquired if the same attention were paid to the track, what would be the possibilities with ordinary steam locomotion, if we were willing to spend large sums of money on the track and on maintenance, approximately as proposed by Mr. Crosby.

Dr. P. H. Dudley:—Our experiments are not sufficiently carried out to determine yet all those points. About the best results are those that I have given you, that is, a reduction of nearly one hundred h. p. per mile, compared with the ordinary sixty-five pound rail. I have designed some one hundred and five pound rails which are nearly one hundred per cent. stiffer than the eighty pound rails. We will probably save on the fast express trains nearly two hundred h. p. per mile, as compared with worn 60 or 65 lb. rails. We have not rolled such a large rail yet; but it will not be long, probably, before that will be done. All trials show a very material reduction in train resistance with the heavy rails, as we increase the stiffness. I think it will be perfectly safe on a track of the 105 lb. rails, to run 120 miles an hour. I have ridden several times seventy-five miles an hour on heavy rails and did not feel it nearly so much as on the light rails when running forty-five miles an hour. There is scarcely any oscillation. The track is in perfect line and the joints are all kept up. I might show you the shape of some of the rails we find in tracks. Taking a thirty foot rail on our best tracks; its surface to the eye would be represented by a straight line. [See Fig. 1.] The joint is well maintained in uniform surface with the other portions of the rail. Take even sixty-five pound rails, after they have been run over a little while, if the joints are laid opposite, we find the rails in this form. [See Fig. 2.] Down at the joints and high in the centre. Now, of course, as the locomotive or train is passing over this depression, it further deflects and the wheels strike on the receiving end of the rail and cut out a piece from the head of the rail. This has been very common. Sometimes the effect is sufficient also to bend the rail down at this point. The apparatus I have on my car ejects paint on the rails where there is a certain deflection. In Fig. 2, it will be noticed the receiving ends of the rails are commencing to cut out. By ejecting the paint, the trackmen have been able to surface the track so that on rails 15 or 16 years old, they have not only checked the cutting out, but have brought up the surface of the rails to a much better condition, and they are nearly in a straight line at the present time. One serious trouble with many of the railroad people is, that while they want a heavy rail, they never consider the question of stiffness. I distribute my metal so as to make the section very stiff, not allowing so much in depth of the head of the rail as usually is done, but widening the head, because when these rails have been in the track a few years, they become worn very unevenly, and must be removed from the track. I am making the heads on that account very much broader and the sections stiff, so the deflection of my 75 and 80 lb. rail is less than one-tenth of an inch in the track. We mark all those rails for any deflection exceeding three thirty-seconds of an inch, under a load of six tons per wheel. That is about as close as the trackmen can work on a sixty-five pound rail. On an eighty pound rail they can work closer, but require great skill. The ejection of paint also shows where there is a rotten or loose tie. The form of rail where the joints are low, and high in the centre, I call the first form. Then there is another form in which the joints and centre are low, and high at the quarters, which I call the second form. [See Fig. 3.] Then there is another rail of which the surface is all full of waves. I call that the third form. [See Fig. 4.] A few years ago that was a very serious matter. We are often able to tell from the diagrams in the car, what mill made the rails as we run over them. That feature has been materially improved by the mills. You will see at once, with trains running over rails of these various forms and with the deflections, there is a large amount of force lost. Rails high in the centre to the eye, will be loose on the ties, so that there is quite a wave under each wheel. Even with very good track we find that under each wheel there is a depression depending on the weight on the wheel and speed of train.

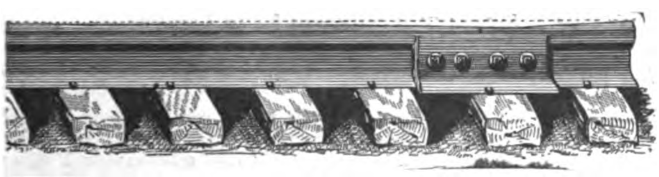


Fig. 2.—Rail Worn Down at Joints.

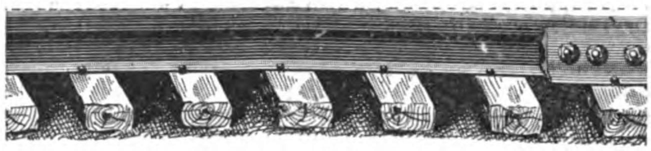


Fig. 3.—Rail Low at Joints and Centre.

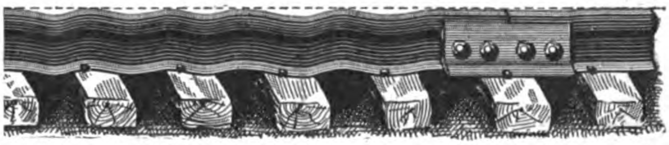


Fig. 4.—Rail With Wavy Surface.

Mr. Lockwood drew attention to the fact that with the increased use of electric locomotives, we may expect to have better preserved tracks, and tracks which, moreover, will hold out much longer; because in the transfer of the rectilinear motion of the steam-piston to its connecting rod and its transformation to rotary motion in the wheels, there is a heavy pounding effect, which will certainly be absent from the motor which has a rotary motion at the outset.

Mr. Frank J. Sprague:—I wish to take the decided position that no automatic system of high-speed service for either passenger, freight, or mail will ever come to a commercial issue. I will go further still: the moment you deny to a man the privilege of traveling 100 or 150 miles an hour you will have a flood of applications from people that want the opportunity.

Mr. Crosby spoke of the possibility of returning the energy of the train to the line, and that it would have very little importance in dealing with the particular class of service of which he has spoken—high-speed service over long distances. That is very true. I think perhaps the value there of a shunt machine, if used, would be on account of the constancy of the speed. That is, it would always be constant within a certain very small limit, especially with machines of the exceedingly high efficiency which would be used under those circumstances. That is where I think, perhaps, the shunt machines would be used. But on local rapid transit service, or service like that of the elevated railroads of New York City—which is not very rapid—but where we have stops every third of a mile, then the importance of returning energy to the line becomes at once very great, because from careful calculations I know it to be possible to return about forty per cent. of the total energy used, back to the line, and the facility with which this can be done increases very rapidly with the size of machine which is used. Where you can use shunt machines, and excite your field magnets up to a very high saturation, and have a very reasonable latitude of variation, the criticism that was made that there would be a loss in energizing the field-magnets more than when in using series machines, I do not think holds particularly good, for this reason: that the total energy used in the field-magnets forms a very small proportion of the total amount of energy used on the line, and if the return energy is forty per cent. of the total, and the field energy of the magnet is only two or three per cent. of the total, the value of this method seems apparent.

The question of traction which has been so ably spoken of by Dr. Dudley has two entirely different bearings. If you are dealing with street car service, it is one thing. If you are dealing with high-speed, clean rail service, it is an entirely different thing. I have found, so far as my practical experience goes, that the dirt on the track, the snow and mud, and the grades, were the questions that determined the power of the motors. When you consider that with twenty pounds traction per ton, the work on a one per cent. grade is equal to the work of traction, and that our street car service demands 12, 13, and even 14 per cent. grade work, the question of rail traction on a level amounts to very little in street car motor design, but it does amount to the greatest possible importance in high-speed service.

Mr. Crosby was speaking, just as I came in, of the influence of currents on traction where the ground circuit is used. I was once a very zealous upholder, especially through our commercial agents, of the importance of using the ground circuit, because of the value of adhesion. My belief was founded on the experience I had with a very dirty track, for which the electricity was perhaps a sort of broom to brush away, or a fire to consume the dirt. I am now of the opinion that the passage of the current, or at least so much current as is necessary for actual traction, has little actual influence on actual adhesion with clean rails. If it has any influence, it simply acts as a cleaner of the track—nothing more than that. [Applause.]

Mr. J. Stanford Brown inquired what limitations would be put upon curvature in this very high-speed service.

Mr. Crosby:—In the paper as read there is a calculation for the limit of curvature as a question of safety. Now there is a very important question as to the effect of curvature in increasing the friction coefficient. On that I have been able to do nothing more than take the text-book formula, and I am not at all sure that they are all right. The matter of safety I have discussed in the paper. The power I have assumed ordinary coefficients for. As to the values of the coefficients in street railway work on straight track, I found with a dynamometer on an ordinary flat rail, about twenty-five pounds average per ton for a car weighing about twelve thousand pounds, that is, a street car, on an average street car track. As to the starting effect, I started a car equipped with the ordinary Sprague motor with fourteen amperes by having a water resistance external to the car. Of course all cars as they are made by all the companies that I know of, take a larger current than that to begin with under any conditions, simply because *C* is equal to *E* divided by *R*. But that current is many times larger than is necessary to start a car. Those 14 amperes started a car on what was practically a level, rusty track; then I put a dynamometer in to check it, and, as I remember now, got about 175 pounds as the effort, applied gradually through a rope and a dynamometer to the starting of this car. That would be about thirty-five pounds—from thirty-five to fifty pounds per ton, and it checked exactly with the calculated torque resulting from the 14 amperes which were used electrically. In other words, I started once mechanically by men hauling on the dynamometer, and then electrically, and they checked very well, running somewhere to 175 to 200 pounds for five tons. Respecting the feasibility of steam as compared with electric traction in case every possible improvement is made, I assumed in the paper I prepared previously on the subject, that the traction coefficient would be the same for the same pull, no matter how exerted. It is so much per ton that has to be exerted. Now the way I took hold was to calculate this very thoroughly—this cumulative load with steam, the coal necessary to be carried, and the water and the surface opposed to the atmosphere in increasing your speed, and I formed a table, which I believe is reliable, showing that at varying ratios for efficiency for electric locomotive machinery, and assuming what we know to be the average efficiency of the steam mechanism at such and such speeds, that you will have an economy greater in the one case or the other, as follows: If you can get ninety per cent. efficiency out of your electric service and have a frequent service—that is, of course, an indefinite term, but I define in my calculation a particular frequency which is not excessive as compared with the local traffic, say, of the New York Central road—with such a frequency with ninety per cent. efficiency and at twenty miles an hour, the electrical propulsion is slightly more economical than steam propulsion. Now, as you increase your speed the relative value of the electrical propulsion increases enormously, and finally, at high speed, say 120 miles, your electrical propulsion is something like six times more economical than steam propulsion, considering steam propulsion even possible. But it is not possible to propel ordinary trains by steam at 120 miles for any length of line worthy of consideration, because the amount of coal and water that you are required to carry has reached a quantity that would require two or three tenders to take care of. You can readily see that it is a cumulative thing. Every pound of coal you put in requires some more coal to be burnt to pull that pound and you have to carry it, and you have water, so that when you get to the high speeds it is out of the question, and we have nothing to look for at very high speeds, save electrical propulsion. But if we come to comparatively low speed service and a comparatively infrequent service, the steam will beat us. [Applause.]

Mr. Pierce:—Do I understand Mr. Crosby then to mean that for heavy freight service steam would be more economical than electricity?

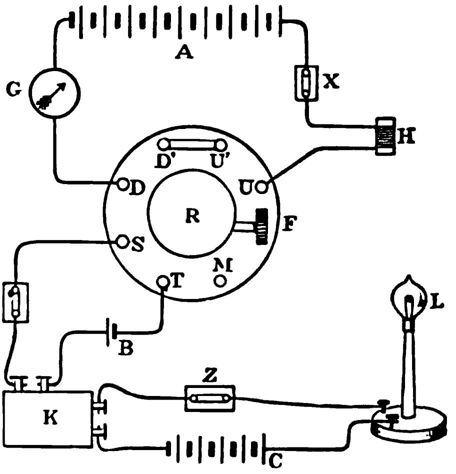
Mr. Crosby:—Yes; I think for heavy freight service, unless its frequency is far beyond anything we have to-day, it can be carried on more economically by steam than by electricity.

Mr. Sprague:—I heartily agree with Mr. Crosby in his opinion regarding the freight service—that it will for a long time be more economically carried on by steam, than by electricity; likewise long trunk transportation. You must understand that electric transmission is going to bring up a new system of train operation, and train despatching.

AN AUTOMATIC LAMP LIGHTER.[1]

BY SHELFORD BIDWELL.

In illustration of a paper on selenium, read at a recent meeting of the Physical Society, I exhibited an electric lamp which was connected with a selenium-cell and a relay in such a manner that the lamp was automatically turned on in the dark and extinguished by the action of light. The details of the arrangement were, however, not described, and I propose to give here a few particulars for the assistance of those who may wish to repeat the experiment.



Selenium Automatic Lamp Lighter.

A scheme of the connections is shown in the annexed diagram. It will be seen that there are three circuits. The first includes a battery A, of 24 small Leclanché cells, the selenium-cell H, and the magnet coils of the relay R. A Post-office tangent galvanometer G, capable of measuring milliamperes, is a convenient but not indispensable adjunct. In the second circuit is a Leclanché cell B, one pole of which is connected through the terminal T with the tongue of the relay R, and the other through the magnet-coils of the electro-magnetic switch K, and the terminal S, with one of the platinum stops of the relay. The third circuit contains the lamp-battery C, the incandescent lamp L, and the tongue and stop of the electro-magnetic switch K. The three simple switches, X, Y, Z, are useful for breaking any of the circuits.

The selenium-cell H has a resistance in the dark of about 50,000 ohms, which is diminished to one-half, or less, by the action of diffused daylight, or by the light of an ordinary gas jet at a distance of 1 foot. The relay R is a "standard relay," as used in the Postal Telegraph service. Its tongue, connected with the terminal T, oscillates between two adjustable platinum stops, which are connected respectively with S and M. (For brevity we will call these the S stop and the M stop.) It contains four magnet-coils

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1. *Nature.*

which, as the instrument is sent out by the manufacturers, may be connected either all in parallel or two in series and two in parallel. For the present purpose it is desirable that the coils should be joined up all in series, thus greatly increasing the sensitiveness of the instrument to small currents at an immaterial sacrifice of rapidity of action. This can only be done by altering the permanent connections underneath the stand of the relay. The terminals D′ and U′ are joined to each other by a brass strap. Care must be taken to join the terminal D to the zinc pole of the battery. The electro-magnetic switch K is simply an ordinary electric bell relay; it is used in order to avoid passing a strong current through the delicate relay R. The lamp L is an 8-volt lamp of 5-candle power. The battery C consists of 5 bichromate or Grove cells; secondary cells, if available, would of course be much better.

The connections being made as above, it only remains to adjust the relay. The platinum contacts must be clean and smooth; those in my instrument are occasionally cleaned with a watchmaker's "dead smooth" file, and then rubbed with a bright knitting-needle. The two stops are screwed up until there is only just room for the tongue to move between them. The milled head F, is first turned clock-wise, so as to make the tongue press against the M stop, and then (the selenium cell being in the dark, or only feebly illuminated) it is slowly and cautiously turned counter-clockwise, until the tongue passes over to the S stop, which causes the lamp to be switched on. If, now, the selenium cell is exposed to a sufficiently strong light, the tongue moves back to the M stop, owing to the increased current through the magnet coils, and the lamp goes out. It is possible to adjust the relay so that the lamp is lighted automatically whenever the external illumination falls below any desired degree of intensity, and the adjustment, when once properly effected, will remain perfect for days or weeks together.

The selenium cell is made by winding two fine copper wires, which serve as electrodes, very close together around a slip of mica, one surface of which is afterward coated with a thin film of selenium. I have given full instructions for the manufacture of these cells in *Nature*, vol. xxiii., p. 58, and need not repeat them here. The cell used for the lamp experiment, measures 2¼ inches by ¾ inch; the gauge of the copper wires is No. 36, and each wire makes 20 turns to the inch. The resistance of the cell in the dark is about 52,000 ohms.

The experiment may be shown by placing the cell near a window, and closing the shutters, when the lamp immediately lights up, going out again as soon as the shutters are reopened. When daylight is not available, the effect may be exhibited in a scarcely less striking way by alternately screening and exposing a gas burner placed at a distance of a foot or two from the selenium, or by turning the gas up and down. The following test illustrates the sensitiveness of the arrangement. The relay was adjusted so that the lamp circuit was just closed when a standard candle was burning at a distance of 7⅛ inches from the selenium-cell. The candle was moved slowly towards the cell, until the distance between them was reduced to 6⅛ inches, when the increased illumination caused the lamp circuit to be broken. The candle was then moved back, and when the distance was once more 7⅛ inches, the circuit was again closed. By moving the candle backwards and forwards over a range of about 1 inch, the circuit could be alternately closed and broken as often as desired. The extreme difference in the strength of the currents passing through the selenium under these changes of illumination was shown by the galvanometer to be rather less than 0.1 milliampere.

Though the apparatus does not at present claim to be anything more than a pretty scientific toy, it is possible that it may turn out to be of some practical utility. To demonstrate its capabilities, I one day left the selenium-cell near the window, with the batteries joined up. At about 4 P. M., just when reading was becoming impossible through failing daylight, the lamp (which I had in fact forgotten all about) was automatically turned on.

College Notes.

LOWELL INSTITUTE, BOSTON.

In 1889 an application was made to Augustus Lowell, trustee of the Lowell Institute, for funds to pay lecturers in several evening courses at the Wells Memorial Workingmen's Institute. He provided funds for the purpose, on condition that the lectures were free, and that the Lowell Institute received full credit in all reports, etc., of the institute. It was then decided to have courses as follows for the winter of 89–90: Carpentry, Elements of Mechanism, Practical Electricity, Steam and Steam Engine.

The course in electricity was the most successful. The first lectures were given by different men, and the interest began to wane. Then Prof. Wm. Puffer, of the Massachusetts Institute of Technology, gave the last six, and made a success of the course. These lectures were very successful considering that there was no power to show the apparatus.

This winter Prof. Puffer gave the entire course of fifteen lectures, and had an average attendance of 106.

The professor treated theoretical and practical electricity generally, taking up all the subjects of the day.

When this course came to an end, a petition was circulated among the men, to see if the professor could give a supplementary course, the cost of which would not be beyond a working man.

The institute offered a room, heat, light and power (I omitted to mention that power had been introduced, and made the lectures more interesting as apparatus could be shown), free of charge on condition that full credit was given to the institute for the class, as an outcome of the lectures given there.

This generous offer was accepted and a course of ten lectures was decided on. Tuesday evening commencing March 10, 1891. The cost for the course of lectures will be $2.50 a person, payable in advance. The professor will take up electric lighting, power, railway, accumulators, etc., in detail. At present there are 25 in the class, and this number will be increased to about 40.

Literature.

First Principles of Electrical Engineering. By C. H. W. Biggs, Editor London *Electrical Engineer*. London, 1890, Biggs & Co. New York, The D. Van Nostrand Company. 5 x 7 inches, 208 pages.

The general tendency of the age towards radicalism, now playing so prominent a part in politics and religion, is felt even to the domain of science, and in the methods of teaching it. An impression has gone abroad that the heads of our youths are being crammed with a variety of information which leaves them in a hopeless condition of repletion and impractibility when they enter the actual work of life; and the cry has been heard that the teaching which is to do the most good in the end should be more practical in its nature, involving less of the higher mathematics, and the information should be generally so placed before the student that the process of assimilation, instead of being a difficult one, shall, as it were, be natural and involuntary.

Mr. Biggs has written the little work before us, on these modern lines, in which attempt, we are free to confess, he has succeeded admirably. The book is not intended for electrical engineers, but for those who intend to enter the profession, and the method of treatment throughout is to give the "principles" in as few words as possible, but to bring out in bold relief their applications. The author passes, after a short introductory on the nature of electricity—which, we may say in passing, he designedly does not attempt to explain—to the conductive circuit, explaining and demonstrating the nature of resistance, defining the ohm and Ohm's law, and then applying analogous reasonings to the static inductive and magnetic circuit.

The author then passes to the methods of practically producing electrical pressure or difference of potential, starting with the static induction machine, the chemical battery, the modern dynamo and transformers. In explaining the subject of the field magnets of dynamos, their strength and their method of calculation from given data, the author has inaugurated a style which it is to be hoped will be more frequently followed to the advantage of the student. His explanations, while elementary in their nature, fully cover the ground and can leave no uncertainty in the mind of the student as to the meaning of the terms and the methods of their application to actual practical work. By means of very simple practical examples, the strength of the magnetic inductive field in dynamo electric machines is worked out, denoting the strength both in lines per square centimetre and in Kapp lines, to which latter the author strongly inclines for practical reasons.

In this connection the author throws out a hint which is worthy of consideration. He suggests that proper authorities should issue sets of magnetic resistances like those of inductive resistances. Manufacturers could then take a piece of iron from the bulk, of certain length of sectional area, wind it with a certain number of ampereturns and balance it against a standard resistance, issuing the bulk of iron as having a certain magnetic resistance per unit length and unit section. This is evidently on the lines of the application of the magnetic bridge, which has not yet, unfortunately, received the attention which its importance deserves. Passing from the field magnets, the author takes up the armature and treats it in a similar manner, showing how the electrical pressure generated in the armature is dependent upon the density of the lines of force cut by the conductor, the velocity with which it revolves and the number of turns through which the lines of force are looped in a given time, illustrating by a practical example the method of application of these principles. The work concludes with a chapter on methods of electrical distribution and on the method of making simple, every-day measurements by the use of the galvanometer, the Wheatstone bridge, ammeter and voltmeter.

As a preparatory course of reading and study, the work will be found not only valuable, but interesting, the style employed being such as to at once enlist the sympathy of the reader who is seeking light on a subject which has on many occasions been enshrouded in mist and mystery, and as such we can heartily recommend it to the many who are taking up this study with a view to future occupation.

Home Correspondence.

PITTSBURGH.

Opposing the Postal Telegraph Lines.—Electric Cars for Funeral Processions.—$100,000 Bouds for the Allegheny City Plant.

THE Postal Telegraph Co. is meeting with opposition in Warren, Ohio, in building its new line from New York to Chicago via Pittsburgh. Some of the landowners in that vicinity are opposing the construction of the line, and the Postal Telegraph Co. has taken the case into court. It has been found that the point at issue has never been decided in the Supreme Court of Ohio, and it will therefore be taken there to establish a precedent. All work on the new line, however, has to be stopped in the meanwhile and a good deal of delay is caused in consequence.

The stockholders of the Suburban Rapid Transit Electric Railway Co., of this city, held a meeting lately for the purpose of formulating a plan to have a couple of new cars built for their road, which are to be used exclusively for the carrying of funerals. There are seven cemeteries located along the line of the company's road and on the average five funerals pass over that route every day. The company now intends to have the cars equipped with electric motors, and they are to be known as the funeral cars.

Last Wednesday night Allegheny councils passed an ordinance providing for the issuance of $100,000 worth of bonds to pay the cost of the city light plant, which was put up last year by the Westinghouse Electric and Manufacturing Co.

There is a bill now pending before the State Legislature of Pennsylvania, which has the object of reducing the rates for telephones. Yesterday all the companies were invited to appear before the committee. The Pittsburgh manager of the Bell Telephone Co. spoke at length against the bill. The burden of his remarks was that his company would not be able to continue in business if the new bill were passed.

PITTSBURGH, March 10, 1891.

Society and Club Notes.

MR. DOBBIE ON ARC LIGHTING BEFORE THE BROOKLYN INSTITUTE.

The monthly meeting of the department of electricity of the Brooklyn Institute was held in the lecture room of the Young Men's Christian Association, Fulton street, on Friday evening, Mar. 6, an audience of nearly two hundred being present.

President Hamblet introduced Robert S. Dobbie, of the Edison General Electric Company, who gave an excellent address on "Arc Lighting," following it up historically from the very first experiment made by Sir Humphrey Davy, down to the arc lights of to-day.

Mr. Dobbie also told of the numberless experiments which have constantly been made since the first production of carbons for arc lights, in 1846.

Mr. Dobbie showed, by an ingenious arrangement, how the carbons of an electric light burn together, forming the arc. It was a successful as well as novel experiment, and brought forth considerable applause, as did the lecture as a whole.

THE AMERICAN STREET RAILWAY ASSOCIATION.

The list of the committees to report at the tenth annual meeting of this Association to be held in the city of Pittsburgh, Pa., the third Wednesday in October (the 21st,) 1891, is completed, and is as follows:

A Perfect Electric Motor.

H. A. Everett, Secretary, East Cleveland Railroad Company, Cleveland, Ohio.

A Year's Progress of Cable Motive Power.

J. C. Robinson, formerly vice-president, Los Angeles Cable Railway Co, Los Angeles, Cal.

Public and State Treatment of Corporations, No. 3.

G. Hilton Scribner, President Central Park, North and East River Railroad Company, New York City.

The Dependent—Overhead or Underground—System of Electric Motive Power.

George W. Mansfield, Director, Attleboro, North Attleboro and Wrentham Street Railway, Attleboro, Mass.

The Independent—Storage or Primary Battery—System of Electric Motive Power.

Knight Neftel, Electrician, Lancaster City Railway Company, Lancaster, Pa.

NEW YORK ELECTRIC CLUB.

The regular meeting of the Club to nominate officers for the year beginning May 1, 1891, will be held at the Club House, 17 East 22nd st., Tuesday evening, March 17, at 8 o'clock.

EXECUTIVE COMMITTEE MEETING OF THE N. E. L. A.

At the executive committee meeting of the National Electric Light Association held at the New York Electric Club on March 14th, Mr. Allen B. Foote requested as a personal favor that his resignation as secretary and treasurer be accepted, to enable him to devote more time to work in connection with the electrical department of the U. S. Census and his economic studies. He reported $1,294.54 in bank and not one dollar of unpaid claims against the Association. Mr. Foote's resignation was accepted, to take effect April 1, 1891. Pres. Huntley nominated Mr. John W. Beane as secretary and treasurer. The nomination was confirmed.

Tuesday, Wednesday and Thursday, August 25, 26 and 27, 1891, were fixed as the dates of the next convention to be held at Montreal, Canada. The headquarters of the Association will be at the Windsor Hotel. It is probable that arrangements will be made for a very large electrical exhibit to be open for the entire week.

The following committees were appointed:—

1. *Committee on Amendments to the Constitution.*—Geo. B. Shaw, chairman; Marsden J. Perry, Hon. E. A. Armstrong.
2. *Committee on Underground Conduits and Conductors.*—M. J. Francisco, chairman; T. Carpenter Smith, A. M. Robertson, John A. Seely, M. D. Law.
3. *Committee on Finance.*—John A. Seely, chairman; E. F. Peck, N. H. Fairbanks.
4. *Committee on Transportation.*—Mr. Edgar, Montreal, chairman; C. O. Baker, C. A. Brown, Henry D. Stanley, A. J. Corriveau.

Mr. John W. Beane, the new secretary of the National Electric Light Association, was educated at the United States Naval Academy and graduated in 1873. He then entered active service and served as an officer in the Navy six years. He then resigned to enter business in civil life. In 1885 he became identified with *The Electrical Review* as one of its editorial staff. Later, he accepted the agency of the Mather Electric Co. for the Middle States. When the Tucker Electrical Construction Company was organized, Mr. Beane became interested in it, and was elected its general manager. In 1890 he accepted a special commission from the United Edison Manufacturing Company in connection with their business in New England, which was terminated recently.

THE NICHOLSON ELECTRIC HOISTING AND CONVEYING MACHINE CO.

An electric hoisting and conveying machine, the invention of Ezra Nicholson, of Cleveland, Ohio, has been in operation during the past few weeks in Cleveland, and has been examined by prominent iron ore and coal men and pronounced an unqualified success. The designing and construction of the plant has been in charge of W. P. Williams, a member of the American Society of Civil Engineers. Mr. Williams and Mr. Nicholson have patented several different systems for the hoisting and conveyance of bodies by electricity, and will shortly organize a company to commence the manufacture of plants for coaling terminals and general work.

This new invention is especially adapted for economic use in loading and unloading vessels or cars of iron ore, coal, or general merchandise, and to convey the load to any desired point. A 30 h. p. Rae electric motor is mounted upon a light tram car holding suitable hoisting mechanism and the operator riding on this car hoists the load from any desired point and rapidly conveys it to the place of unloading. The presence of the operator always over his work has a great advantage over steam automatic cable systems in present use.

The present work performed by the plant is unloading a vessel of iron ore, hoisting a load of 3,000 lbs. vertically 5 feet per second, then traveling across a bridge 30 feet high and 200 feet long spanning the ore dock, the cross travel being made in ten seconds, and the operator stopping the car holding the bucket and dumping the load at any desired point. Systems have been designed for quarry, rolling mill and contractors' use by Messrs. Nicholson and Williams.

NEW YORK SUBWAYS.

According to President Lauterbach, the subway company built 65 miles of subway last year, but less than five miles were occupied. Seven of the electrical companies have applied, however, to the Board of Electrical Control for more subways, some of which would run under streets recently repaved. New lists are to be prepared showing where the wires can be taken down and put underground, and then other subways may be ordered.

Reports of Companies.

ELECTRIC LIGHTING CONSOLIDATION IN ST. LOUIS.

At a meeting of the Laclede Gas Light Co. on May 2, a proposition will be considered to increase the capital stock from $10,000,000 to $12,000,000, the increase being in common stock. The object of this is to perfect the purchase of the properties of the Missouri Electric Light and Power Co., and of the Municipal Electric Light and Power Co., of St. Louis.

The sum of $2,000,000 was paid for the Municipal, its plants, wires, franchises and contracts. Of this sum $1,500,000 was paid in cash, and $1,500,000 in common stock, worth about $300,000 on the market, or $1,800,000 in all. The floating debt of $600,000 was assumed by the Laclede, making the total about $2,400,000, and about $400,000 of the unsold bonds of the Municipal were turned over to the Laclede, leaving the net cost $2,000,000.

The negotiations with the Missouri Electric Light Company were speedily concluded, the Laclede agreeing to pay $1,100,000 for the plant and to assume the bonded indebtedness, while the floating debt was to be taken care of by the Missouri Company.

THE AMERICAN PROJECTILE COMPANY.

The directors of the Thomson Electric Welding Company have issued a letter to the stockholders of that company in regard to the new Projectile Company. The circular states that in 1889, Lieut. Wm. M. Wood, U. S. Navy, associated himself with the Welding Company and conceived the idea of adopting the welding process to the manufacture of various kinds of shells. A series of expensive experiments had been carried on at the welding factory in the manufacture of both armor-piercing shell for navy use and shrapnel for the army. These experiments resulted in the receipt of substantial orders for these supplies for use in both the army and navy.

As the business of the Electric Welding Company is solely the manufacture of electric welding machines, the directors decided that it was advisable to organize the American Projectile Company, with a capital of $500,000. Two hundred and fifty thousand dollars in the stock of the new company is to be paid to the Thomson Electric Welding Company, for its United States projectile patents and the exclusive use of the welding process for the manufacture of shell in this country. The remaining $250,000 of the stock of the company will be sold at par for working capital.

THE UNION SWITCH AND SIGNAL CO.

At the annual meeting of the Union Switch and Signal Company, one of the eight Westinghouse corporations, the old directors, headed by President George Westinghouse, Jr., were ousted and a new board elected.

The whole thing, which was a tremendous surprise, was accomplished by Secretary A. T. Rowand, who voted the proxies for a new ticket, which included himself.

Mr. Rowand is accused of having voted proxies in direct violation of the wishes and commands of the stockholders who gave him the papers.

The new board consists of Edwin F. Waters, W. Scott Fitz and Sigourney Butler, of Boston; Henry C. Terry and Owen B. Jenkins, of Philadelphia, and G. Shane and A. T. Rowand, of Pittsburgh.

Three prominent members of the old board and defeated ticket are President Westinghouse, his brother Herman S. and Robert Pitcairn, the superintendent of the Pittsburgh division of the Pennsylvania Railroad Company. Steps have been taken, however, to have the election set aside, and Mr. Westinghouse has installed men acceptable to himself.

THE HUDSON RIVER TELEPHONE CO.

The report of the above company shows a net revenue of $51,505.41, plus the surplus of $15,867.71 of January 1, 1890, making an amount on hand of $67,378.14. Out of this four dividends were paid, amounting to $41,208.14, leaving a surplus January 1, 1891, of $26,165, which, with the proportion of Westchester earnings, leaves a total surplus of $49,837.13. The company's resources are $2,078,840.14; liabilities, $2,052,675.14.

It has become essential to secure a permanent location in Albany, and a lot, 21x85, on the corner of Chapel and Maiden lane, has been purchased at a cost of $9,000. Plans are being prepared for a three-story and basement building to cost about $25,000.

DIVIDENDS.

LYNN, MASS.—The Lynn Belt Line Street Railway Company has voted to pay a dividend of 5 per cent. to all stockholders July 1, 1891.

WESTERN UNION TELEGRAPH CO.

For the quarter ending March 31, the net revenues of the Western Union Telegraph Company are estimated at $1,500,000. After deductions for interest on bonds, sinking fund payments, and $1,077,400 for a 1¼ per cent. dividend on the stock, a net surplus of $11,321,137 is figured out. The directors have recommended the payment of a dividend of 1¼ per cent., payable on and after April 15.

ELECTIONS.

IONIA, MICH.—At the annual meeting of the Ionia Electric Company, Directors L. B. Townsend, H. R. Wagar, J. E. Just, C. J. Rumsey, and A. S. Wright were re-elected, and the directors re-elected President Townsend, Vice-President Wagar, and Secretary and Treasurer Just.

PATCHOGUE, N. Y.—At the annual meeting of the stockholders of the Patchogue Electric Light Works the following board of directors were elected: John S. Havens, Jesse C. Mills, Andrew Fishel, George D. Gerard, John H. Mills, Frement Hammond, Edwin Bailey, Nathaniel O. Sweezey, Hallett J. Bishop, Henry Gillette, and Isaac G. Willetts. The officers were elected for the ensuing year as follows: President, J. S. Havens; vice-president, J. C. Mills; secretary, N. O. Sweezey; Treasurer, J. H. Mills; executive committee, H. J. Bishop, G. D. Gerard and J. C. Mills.

Appointments, Etc.

MR. J. ALLAN HORNSBY has been appointed secretary of the Electrical Bureau of the Columbus Fair by Commissioner J. P. Barrett.

MR. W. A. CARY, of the Thomson-Houston Electric Co., has just been made treasurer of the Plymouth, Mass., Electric Light and Power Co., and the Seneca Falls, N. Y., Electric Light Co.

MR. C. H. REYNOLDS.—When Mr. C. H. Reynolds retired from the superintendency of the Omaha electric lines, the motor men and conductors presented him with a handsome diamond pin as an expression of their good will and feelings toward him. The new superintendent, Mr. Stone, has assumed the duties of his office.

MR. WILLIAM H. JONES, for the past eight years manager of the Western Union telegraph office in Lowell, Mass., has tendered his resignation to take effect as soon as his successor can be appointed.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of March 14, 1891, from New York, Boston and Washington; Pittsburgh, March 6.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80¼	Edison Gen. Elec. Co	108
American Tele. & Cable	79¼	Edison Gen. Co. Def'd	... [illegible]
Centl. & So. Amer	....	Consol'd Elec. Lt. Co	....
Mexican		Edison Ill'g Co. N. Y	.. [illegible]
Com. Cable Co	106	U. S. Elec. Lt. Co	. [illegible]
Postal Tel. Cable	...	North Am. Phonograph	.... [illegible]

BOSTON.

	BID.		BID.
Thomson-Houston	43¾	Ft. Wayne Co	12¾
" Pref'd	25½	Am. Bell	199
" Series C	...	Erie	47¼
" " D	6¼	New England	50
" Int. Co	210	Mexican	.90 cts.
Thomson Welding Co	....	Trop. American	.60 cts.
Thomson Eu. Welding	55	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash	184
Ches. & Pot. Telephone	57	Eck.&Sold. Home Elec. Ry.	56½
Amer. Graphophone	7	Georgetown & Tenallytown	58¼

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	10⅞

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 10, 1891.

Alarms and Signals :

Electric Railway-Signal. W. W. Rosenfield, 447,906. Filed May 17, 1890.

Adapted to the block system ; provides for giving an alarm in the cab of a locomotive or at another part of a train when it enters upon a block in case a predetermined succeeding block be occupied by a train either moving or stationary.

Electric Railway Signaling Apparatus, E. L. Harrison, 418,081. Filed March 4, 1890.

Adapted to denote at all times the presence or absence of trains upon certain sections or blocks of a railway ; the signal circuits are actuated by the passage of the engine or cars.

Train-Order Annunciator, L. T. Crabtree, 418,125. Filed July 11, 1890.

Adapted to prevent the telegraph operator at any station (unless intentionally negligent) from receiving train-orders until he has set a train-order-signaling device on the track, and to insure the exhibition of such train-order-signals while the operator has in his hands an order received for an approaching train ; enables a train conductor who has been signalled to ascertain without inquiry if an order or orders await his arrival.

Electric-Light Signal, W. R. McCann and S. S. Creider, 447,894. Filed Sept. 8, 1890.

Designed to enable signal lights at several stations to be severally lighted or extinguished from a central station; adapted for service at police stations or at points between telegraph offices on railways to call attention preparatory to communicating information from a central station by telephone, telegraph or otherwise.

Electric Alarm, G. W. Adams, 447,998. Filed June 6, 1890.

Relates to a protective system for buildings, and consists chiefly in the use of two independent circuits between a central station and and the building or buildings to be protected, one an open circuit and the other a closed circuit.

Combined Push and Pull, A. Iske, 418,044. Filed June 27, 1890.

A combined push-button and pull-knob by which either a pressure or a pull will close an electric bell circuit.

Polarized Annunciator, E. P. Warner, 448,169. Filed Jan. 9, 1890.

Consists in providing, in connection with the poles of an electro-magnet, a pivoted permanent magnet so arranged as to hold the shutter or drop while current in one direction is passing and to release it when a current in the opposite direction is passing.

Signal Box, F. W. Cole, 447,869. Filed Dec. 23, 1890.

Adapts to a signal-box, with a train and signal-wheel, a switch for shunting out the signal-wheel and another switch for cutting out the signal wheel, the switches being operated in succession, first to shunt out and afterward to cut out the signal wheel.

Conductors, Conduits and Insulators :—

Coupling for Electric Wires, C. M. Knight and T. Hawken, 447,833. Filed Nov. 20, 1890.

For joining wires end to end.

Conduit for Electric Wiring in Buildings, S. Bergmann, 447,861. Filed Aug. 1, 1890.

Consists in providing a seat, or seats placed at various points, in conduits for interior wiring, adapted to receive a switch and includes details of construction and arrangement of the switch.

Insulation of Electric Conductors, F. J. Nash, 447,896. Filed May 12, 1890.

Claim 1 follows :

An electric conductor insulated by a surrounding bed or layer of insulating material in the condition of an impalpable powder, whereby the particles thereof are packed together so closely as to exclude air and moisture.

Electric Conductor, F. J. Nash, 447,897. Filed May 13, 1890.

Aims to provide a flexible conductor of high insulation. The conducting wire is enclosed in a layer of pulverized insulating material the particles of which are free to move relatively, the insulating material being enclosed in a retaining envelope.

Dynamos and Motors :—

Electric Starting Switch, W. Hochhausen, 447,827. Filed Nov. 26, 1889.

For electric motors ; consists in combining with an electric motor and its main starting switch a secondary switch controlling a resistance or other device for preventing damage to the armature at starting, and an actuating device for the secondary switch operated by the main switch, but having a lost motion so that the resistance or safety device may not be cut out until after some interval of time when circuit has been closed on the motor ; thus enabling the motor to acquire speed and counter electromotive force during such intervals of time.

Alternating-Electric-Current Generator, N. Tesla, 447,921. Filed Nov. 15, 1890.

Claim 1 follows :

The combination in an annular field of force formed by opposing polar faces with radial grooves or serrations and with said poles, of a connected series of radial conductors so disposed with relation to the serrations that while one portion of the radial conductors is passing between the strongest parts of the field, or the points where the two poles most nearly approach, the adjacent or intermediate conductors will pass through the weakest parts of the field, or the points where the two poles are most remote.

Electric Motor, W. H. Chapman, 447,939. Filed July 5, 1890.

A multipolar motor with a series of field-magnet cores arranged in pairs, the two cores in each pair are placed parallel to the axis of revolution and connected together in one piece, but separated from contact with the cores of the adjacent magnet and having their pole ends curved tangentially to a plane at right angles to the axis of revolution in both directions from the centre of each of the cores.

Commutator, W. Hornberger,. 448,040. Filed Aug. 2, 1890.

The commutator section has a side edge protected or strengthened by metal of greater density or hardness.

Lamps and Appurtenances :

Electric-Arc Lamp, H. C. Forgason, 447,767. Filed May 23, 1890.

Relates especially to the cut-out. Provides for bringing the carbons into close contact when exhausted.

Electric-Light Fixture, J. Kintz, 447,832. Filed May 15, 1890.

Design and construction for a bracket fixture.

Method of Operating Arc Lamps, N. Tesla, 447,920. Filed Oct. 1, 1890.

Claim follows :

The method of abating or rendering inaudible the sound emitted by arc lamps supplied with or operated by an alternating or pulsating current by increasing the rate of such alternations or pulsations up to that of the limit of audition.

Electrode for Arc Lamps, A. C. Seibold, 448,084. Filed Dec. 24, 1890.

Provides a holder or casing for the positive carbon, consisting of a metallic tube with an interior diameter freely admitting the carbon; at the lower end of the tube is a removable flat plate in immediate proximity to the arc and having an opening of less diameter than the carbon.

Device for Raising or Lowering Incandescent Electric Lamps, C. F. Reinmann, 448,164. Filed Feb. 8, 1890.

An adjustable suspension device.

Automatic Switch-Board and Safety Cut-Out for Electric Circuits, E. A. Sweet, 448,166. Filed Oct. 22, 1890.

A device for short-circuiting automatically any one of a number of circuits connected in series for electric lighting in case of accident and without disturbing other circuits.

Switch for Incandescent-Lamp Sockets, A. T. Tregurtha, 447,167. Filed Sept. 20, 1890.

Details of design and construction.

Electric Arc Lamp, La M. C. Atwood, 448,107. Filed Oct. 28, 1890.

Relates to the class of lamps employing a motor for moving the carbons ; details of mechanism.

Medical and Surgical :—

Galvanic Apparatus for the Human Body, P. G. Williams, 447,857. Filed June 6, 1890.

Includes a flat battery adapted to be worn upon the person.

Body-Battery and Attachments for the same, J. A. Crisp and G. F. Webb, 448,128. Filed Nov. 21, 1890.

Similar in purpose to the above.

Miscellaneous :—

Electric Switch, J. M. Orford and J. C. English, 447,783. Filed Dec. 19, 1890.

Relates more particularly to switches of the double-pole class ; adapted to make or break contact by a pushing movement.

Electric Switch and Cut-Out, W. Hochhausen, 447,826. Filed Mar, 12, 1889.

Designed to control the flow of current to an electric translating device ; adapted for both manual and automatic operation ; suitable for attachment to ceilings or to in-door apparatus.

Electric Switch, H. T. Clark, 417,867. Filed Jan. 26, 1891.

A quick-acting or "snap" switch.

Current Wheel, W. Stephens, 447,915. Filed Mar. 21, 1890.

A system of current-wheels and floats adapted for the transmission of water power to drive a dynamo.

Electric Door-Opener, L. Bates, 448,110. Filed July 14, 1890.

Adapted to control a pivoted latch through electro-magnetic apparatus.

Railways and Appliances :—

Trolley Carriage and Conductor, C. J. Luce, 447,885. Filed Apr. 4, 4890.

The trolley-carriage is provided with a wheel or pulley above and also one below the wire, a rigid arm pivoted to the carriage at a point between the wheels or pulleys is connected to the roof of the car by a flexible conductor.

Trolley for Electric Railways, M. J. Wightman, 448,172. Filed Aug. 12, 1890.

The trolley arm is provided with a practically universal joint, and a spring tension device tending to move the arm into vertical position, so that the direction of pressure between the trolley and the trolley wire is always in a plane nearly parallel to the wire. The invention also includes special devices for suspending the conductors, and details of frogs, turnouts and junctions.

Trolley for Electric Railways, M. J. Wightman, 448,173. Filed Aug. 12, 1890.

A trolley arm having a practically universal joint is provided with a gear to prevent the twisting of the arm. Invention includes details of line construction and is adapted especially to a two wire or double trolley system.

Telegraphs :—

Railway-Car Telegraphy, W. S. Cook & M. C. Cook, 447,943. Filed April 21, 1890.

A system of telegraphing to or from moving trains in which actual contact is made with overhead conductors.

Telephones and Apparatus :—

Combined Annunciator and Telephone System, J. C. Francis, 447,768. Filed Nov. 5, 1889.

A combined annunciator and telephone system adapted for use in hotels and other buildings and enabling the ordinary annunciator to be used without an expensive change in including a telephone circuit.

Induction-Preventive for Telephones, T. F. Wright & E. G. Wilson, 447,858. Filed July 28, 1890.

Adapted for attachment to a receiving telephone. Claim 5 follows :

The combination with a telephone receiver and the diaphragm thereof provided with a central perforation of an induction preventive comprising a hollow casing provided with perforations, a tube extending between said perforations, a spool located within said casing, and a metallic coil wound upon said spool, one end of which is embedded in the spool and the other terminates opposite the centre of the perforation in said diaphragm.

Telephone-Toll Apparatus, W. Gray, 448,024. Filed April 5, 1888.

A "nickel-in-the-slot" apparatus.

Automatic Telephone-Exchange, A. B. Strowger, 447,918. Filed March 12 1889.

Claim 1 follows :

In a system of telephone, telegraph, or other electrical exchange, the combination, with a series of wires leading to different stations in the system and having their ends insulated and held in curved rows, of a contact needle supported at the axis of the rows, mechanism for moving the needle from row to row, mechanism for moving the needle along the row, magnets for actuating said mechanisms, and wires leading from a sub-station for conducting electricity to energize the said magnets.

Apparatus for Intensifying Electrical Undulations, J. C. Ludwig, 448,153. Filed Sept. 10, 1889.

A telephonic repeater. Employs in connection with a telephone receiver, a local battery circuit with its poles adjacent to the diaphragm, loose granular particles of carbon or other conducting substance placed on the diaphragm to complete the local battery circuit, and one or more secondary circuits interposed between the line wire and the bobbin of the receiver.

Moore Electric Mfg. Co. will remove May 1, to corner Thirteenth and Hudson, this city, which will give them four times their present accommodations. They will carry on the manufacturing of electrical apparatus and supplies, branch blocks, sockets, cutouts and the sale of larger apparatus and wire.

Mr. James P. Francis will, it is said, be appointed superintendent of the Southern Massachusetts Telephone Co., of New Bedford, in place of Mr. Moses E. Hatch, whose feeble health compels him to retire.

THE PATENT CENTENNIAL AT WASHINGTON.

The committee in charge of the Patent Celebration, to be held in Washington, on the 8th, 9th and 10th of April, announce that in view of the limited seating capacity of the largest public hall in Washington, it has been found necessary that admission to the public meetings, at which addresses will be delivered by distinguished speakers, will be by ticket only. This rule will also hold for the public reception to be given at the patent office and for the excursion to Mount Vernon. Persons desiring to attend the meetings and participate in the reception and excursion should make application at once to J. Elfreth Watkins, secretary of the executive committee, 811 G street, N. W., Washington, D. C.

MOTORS FOR PRINTING OFFICES.

There is a marked appreciation of the electric motor in printing offices, where its ability, if of good design and construction, to stand up under severe strain and to occupy little floor space, has often proved of the utmost advantage to the user. The favor enjoyed by the motor is seen in the fact that it is being adopted for a very large number of new offices. Thus, the Lancaster, Pa., *New Era*, in occupying a handsome building erected specially for its work, has bought from the Elektron Manufacturing Co., of Brooklyn, a 20 h. p. Perret motor, which will not only run the Goss newspaper press, but will operate two or three smaller presses, the wetting machine, the freight elevator and the stereotyping plant. This is no small job for one modest motor, but the Perret will stand it, and come up smiling. A 10 h. p. Perret motor has also been put in to run the *New Era* job printing office. One of the reasons, the paper says, influencing the purchase of these two motors was the fact that they run at such a moderate speed as not to require countershafting to reduce the speed of the main shaft.

Another paper that is making a move is the veteran and vigorous *Commercial Advertiser*, which has lately afforded electricians and electrical engineers the best opportunity to state their opinions and ideas that they have ever had from a daily paper. The *Commercial* will occupy new quarters on Park Row about April 15, and will put in a 20 h. p. Perret motor to run its Hoe presses. Mr. Harold Godwin, the editor, has given this matter his personal attention, and would be satisfied with none but the best.

NEW YORK TRADE NOTES.

Bateman & Pollard.—At a dinner given by Mr. Isaac Stern, 835 5th ave., last week, a novel electrical display was provided by the above firm and formed a unique part of the decorations. Here and there interspersed among the floral decorations were 4 c. p. lamps covered by varied-hued silk hoods, the effect being very striking. The electricity for this display was obtained from accummulators located beneath the table. The affair was a pronounced success and Messrs. Bateman & Pollard feel very much gratified. This firm is at present installing a 1,200 light plant at the Jewish Temple, Bethel; a complete electric light plant of 300 lights including boilers, engines, dynamos, storage batteries, etc., at the residence of Mr. J. B. Newton, Tarrytown, N. Y., and the central station at Schroon Lake in the Adirondacks, for Mr. H. B. Parshall, of this city, to light up Taylor & Sons' hotel and 15 summer cottages, including Mr. Parshall's summer residence. This plant is also furnished with electric motors for pumping water from a spring to a reservoir. Another feature of this plant is a weather vane up in the mountains, recording in Mr. Parshall's residence in the valley below. Mr. Parshall is also fitting up a pleasure launch for use on the lake with electricity as a motive power.

Mr. A. G. Goldmark, of Wallace & Sons, 29 Chambers street, this city, has just returned from an extensive trip through the South and Southwest, and reports the outlook for business in the railroad line as assuming a condition of things which will result in a great deal of construction being done during the coming summer.

Mr. G. R. Turnbull, general manager Butler Hard Rubber Company, 33 Mercer street, this city, has recovered from a severe illness, and is now back in the office.

Taylor & Sons, 39 Dey street, report the sales of their battery as very flattering, and they are reaping the advantage of having at last got a good and substantial primary battery. The battery is so made that its solution, should it happen to be spilled on carpets, will not destroy them.

Mr. W. D. Baldwin, general manager Otis Elevator Company, has returned from a trip to Chicago and the West, which he visited on behalf of the Otis Elevator Company.

The Crescent Insulated Wire and Cable Company, of Trenton, N. J., have lately been organized and are in the field with a superior make of seamless rubber insulated wires and cables. They will use nothing in the manufacture of their wire but the highest grade of Lake Superior copper and fine para rubber, and their manner of treating the caoutchouc in their compounds is such as to secure the highest degree of insulation resistance. Their factory is thoroughly equipped and they will no doubt get a good share of the business in this line.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Advertising is the absolute pre-requisite to the sale of goods."

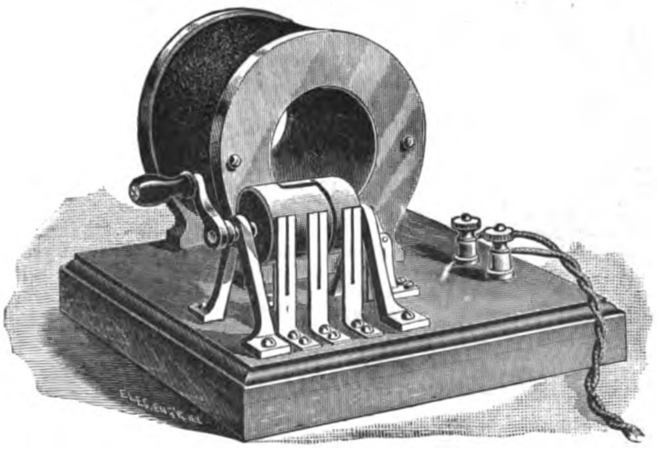
THE BERLIN WATCH DEMAGNETIZER.

BY

Jas Jones &

For a number of years experiments have been going on to perfect a demagnetizer for watches, and numerous contrivances have been the outcome of this work. The simplest of these is that made up of a number of horse shoe magnets, crossed at their curves, and attached to an upright rod, which runs through an opening in a brace mounted upon a standard. The rod is employed to revolve the magnets, and this operation brings to whatever is put before them, first one pole, and then the other, reversing the charge as each point comes to the object. This so-called demagnetizer is in reality not much more than a toy, for it takes out very little magnetism, but affords the operator some amusement. It has in it, however, the principle upon which a demagnetizer for practical work is built.

Such an instrument is that shown in the accompanying engraving, which is the invention of C. F. Berlin, who spent considerable thought, and experimented broadly to bring it to a useful form.



The Berlin Watch Demagnetizer.

It consists of a demagnetizing chamber, about which is wound a coil of wire. The commutator is provided with an operating handle attached, having two dead points and two opposite insulated plates, and four brushes; two of the latter connected with the coil, and two with a pair of binding posts, through which the current is brought to the demagnetizer.

The object to be demagnetized is placed within the demagnetizing chamber, the current having been turned on, and the commutator is revolved rapidly, causing a current to alternately pass in opposite directions through the coil. A few seconds of this operation suffices to do the required work, the object being gradually withdrawn from the coil.

As first designed by the Berlin Demagnetizer Co., the coil was made up by rivetting the proper size of sheet fibre into two wooden standards forming the ends upon which the wire was wound. A strap key was used to put on the current, as it was found necessary to have some means of positively opening the circuit after the operation. Where a key was not used the operator frequently left the current on, and the coil necessarily suffered.

The company has lately given to the firm of J. Jones & Son the sole agency for its now popular instrument, and they have made considerable improvement in it. The key has been done away with, and in its place is used a spring switch of the same principle as that in the old magnetos. The commutator, when operated, is pressed in against the switch bar, and must be held so to receive the current.

The spool is now made of rubber, the wire being covered with a sheet of velvet. This is mounted in two nickeled brass standards, and the whole mechanism is placed on a nicely moulded base. The binding posts are also improved, having knobs on their screw tops, holding the thumb screw portions on, so that they cannot be lost.

T. M. FOOTE REGULATOR CO.

The above company have removed from 271 Franklin street, Boston, to 952 Exchange Building, that city. Their works are at Ashland. Their Western agents are Chandler & Littlefield, 40 Marine Building, Chicago.

SAMSON CORDAGE WORKS.

The Samson Cordage Works, of 164 High street, Fort Hill Square, Boston, Mass., are to remove on April 1, to new offices at 115 Congress street, that city, where they will be pleased to receive or hear from all their old friends in the electrical field.

THE PAGE BELTING COMPANY.

This company manufacture in their extensive works at Concord, N. H., all the staple grades of leather belting, making specialties of wide main belts, particularly for electric plants, and also of a special grade of single belting, which they call their "Crown Extra." During the past year they have added to their specialties for electric work, their Acme link belts, of which they have sold a large number, some of them being put to very hard work, and running at considerably more than a mile per minute with the very best of service. They also report large and increasing sales in their double flat dynamo belts.

This establishment now has stores in Boston, Chicago and San Francisco, and at No. 16 Dey street, New York, where they have a complete stock of staple and special grades of belting, including lace leather, both raw hide and tanned.

"THE BEST," "SUPERIOR TO ALL OTHERS."

All who contemplate purchasing a medical battery should read the following late extracts from the daily business letters received by Jerome Kidder M'f'g Co., the old established firm at 820 Broadway, New York.

L. Dowse, M. D., writes from Petoskey Sanitarium, Petoskey, Mich., March 3rd, 1891: "Have used your batteries for four years and think them the *best out*. Have an almost new —— battery I would exchange for anything in shape of a Kidder." W. H. Hoag, Esq., of Amsterdam, N. Y., writes, Feb. 10th, 1891: "I have used your battery for the last six years, it is *the best*. Would not do without it for twice what it cost." And J. H. Mosely, M. D., of Tomah, Wis., writes under date of Feb. 12th, 1891: "I have had a varied experience with electric batteries, but yours prove *far superior to all others* in the treatment of chronic and acute diseases."

THE LUNKENHEIMER BRASS MFG. CO.

This company announces the purchase of the entire plant of the Porteous Brass Mfg. Co., of Cincinnati, O., and the removal of the machinery and tools to its new addition at Nos. 11 and 13 East Eighth street, in that city. The company is in excellent condition, and, notwithstanding extremely sharp competition, has been again compelled to enlarge its factory.

B. F. STURTEVANT & CO.

A finely illustrated 200 page catalogue of blowers, heating and drying apparatus, portable forges, engines, etc., has just been issued by the B. F. Sturtevant Co., Boston, Mass. It is devoted principally to the general line of goods and method of introduction, as special catalogues are published, relating to the different departments of work. The value of the catalogue to engineers is well voiced in the "Introductory" from which we quote: "The first comprehensive and authentic tables and diagrams relating to the action of the air under pressure, and to the speeds, pressures, capacities and powers required upon all classes of blowers were published in our celebrated catalogues of 1870 and 1873. The information and tables therein contained have formed the basis of all computations of the movement of the air by fans, and have been extensively copied, but not originated by other manufacturers. The constant demand by engineers for these tables led to their careful revision and the introduction of much new material, and they are here presented as the only authentic data relating to fan blowers." The catalogue bears marked evidence of the prosperity of this firm, and of its thorough acquaintance with the branch of engineering in which it is a leader.

SOLDERING SALTS

It will interest those who use soldering salts to learn that The Electrical Supply Co., of Chicago, has decided to handle hereafter, only chemically pure zinc chloride, the commercial article having proven unsatisfactory in some cases. The pure material is readily distinguished by its whiteness and superior strength.

TRUEX & VAIL.

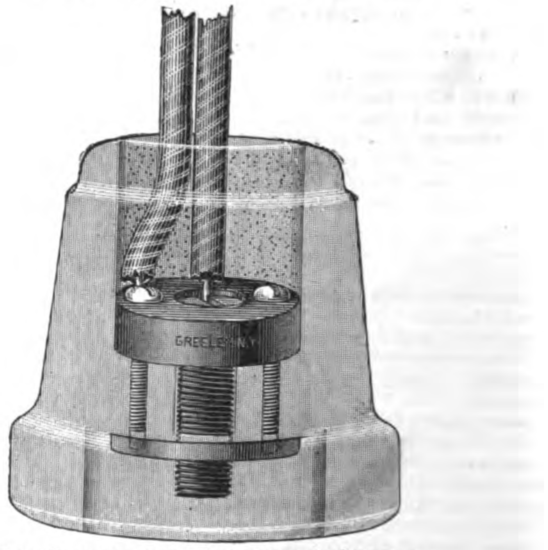
A partnership has been formed by C. R. Truex and W. A. Vail, under the name of Truex & Vail, with headquarters at 44 Broadway, this city. Both gentlemen have had a long experience in the electrical field. They will act as general sales agents for the Accumulator Co, the Electro-Dynamic Co. and the Walker Electric Co, and will handle Edco dynamos and motors, switches, Walker recording ammeters and voltmeters, direct reading ammeters and voltmeters, storage batteries, etc. These specialties constitute an admirable line and are already well known to the electrical profession and trade. The firm are also prepared to furnish electrical supplies and do general construction. For the specialties named, they have secured the exclusive selling agency in New York, New Jersey and adjacent territory.

ROBINSON RADIAL CARS.

Mr. H. A. Everett, the secretary and treasurer of the East Cleveland Railroad Co., writes us that they have purchased a long Robinson radial truck car, which will be between 32 and 33 feet long, and which they hope to get running in a few days.

THE CARTWRIGHT WATERPROOF SOCKET.

AMONG the many new and approved appliances for electric light work that are constantly being brought out by The E. S. Greeley & Company, is a thoroughly waterproof socket, which is illustrated in the accompanying engraving, and which seems to leave little to be desired in the way of a fixture of this kind.



THE CARTWRIGHT WATERPROOF SOCKET.

It is the invention of a practical as well as a theoretical electrician, whose name the socket bears, it being called the Cartwright Waterproof Socket, and has the following distinct features: The porcelain itself, which forms the shell of the socket, instead of being the common porous article, merely glazed over, is a thoroughly vitrified substance, completely impervious to moisture. The metal parts are fastened to the porcelain frame in a workmanlike manner and do not depend for their security upon the sealing compound. The sealing compound itself is of a quality that will stand a zero temperature without deterioration and at the same time will endure the heat that results from a 3 ampere lamp, without softening.

When it is considered that the device is designed simply to meet the requirements of lamps of ½ to 1 ampere capacity, the large margin allowed will be better appreciated.

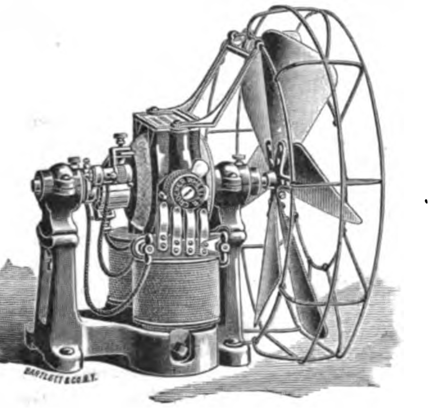
The Cartwright Waterproof Socket is made in three patterns to accomodate lamps of the Edison, Thomson-Houston and Westinghouse types. They are made, as shown in the illustration, with rubber insulated terminal wires projecting several inches from the shell to admit of rod connections.

THE GORHAM MANUFACTURING CO., silversmiths, of Providence, R. I., have issued an exceedingly tasteful little brochure by Mr. Scott A. Smith, on "The Source and Nature of Electricity and its Application to the Electro-Plating Process." The book consists of brief notes, each of which enters into a simple statement of facts or the explanation of phenomena. There are some pretty cuts and a complete index. A great many members of the National Electric Light Association visited the Gorham works during the Providence Convention, and will remember how scientifically the processes mentioned in this pamphlet were carried out. The company has been making solid silverware since 1831, and plated ware since 1865.

THE CROCKER-WHEELER ELECTRIC FAN.

The small electric fan combination is a device which has been improved upon until it has now reached a very high state of excellence. The present style made by the Crocker-Wheeler Company, of West 14th and Washington streets, is shown in the accompanying illustration, and is so arranged that no external resistance is necessary to regulate the speed of the fan, the motor being wound in such a manner that, by simply turning a switch, its speed may be reduced one-half.

These machines are made in three sizes, for use in private houses, small halls, etc., and also in a number of larger sizes up to, and including, ventilating wheels, and exhaust fans 60 inches in diameter for large public buildings.



¼ H. P. Crocker-Wheeler Fan Motor

QUEEN & CO.'S INSTRUMENTS.

The ammeters and voltmeters of the "Magnetic Vane" type made by this firm are meeting with great favor for central stations and isolated plants. They are accurate, contain no permanent magnets and may be left in circuit continuously. Special instruments for any current or E. M. F. are made to order by Queen & Co.

The following testimonials attest the merits of these instruments:—Robinson & Cary Co., St. Paul, Minn. "The magnetic vane ammeters and voltmeters which we have had from you have been entirely satisfactory." Southern Electric Co., Lynchburg, Va. "All the magnetic vane instruments purchased from you have given absolute satisfaction as commercial instruments, and have shown up remarkably well in laboratory work of a general character." Edison General Electric Co., New York. "They have given us very excellent satisfaction, and it affords us pleasure to recommend these instruments." New York and Pennsylvania Telephone and Telegraph Co., Elmira, N. Y. "The magnetic vane ammeter "138," purchased of you, is giving entire satisfaction. This ammeter is in daily use in our testing department, and has always been found reliable and accurate."

THE HUB LINE WIRE

This is a new waterproof wire recently brought out by the Eastern Electric Cable Co., of Nos. 61–65 Hampshire street, Boston. It is known as the "Hub" line wire. The rubber covering is the same as that used on the celebrated Clark wire, made by this company, and over the rubber is a double braid coated with "Clark's patent compound," which makes it very strong and durable. The outside coating being composed largely of a mineral wax, is absolutely weatherproof, and, if subject to chafing, takes a fine, smooth polish.

In a test of this wire at Buffalo, N. Y., the wire was immersed for 24 hours, and dried for 14 hours, alternately for 93 days. The insulating covering was wound for the space of one foot with bare copper wire, the ends of which were attached to a tangent galvanometer, and a current of 1,500 volts pressure passed through the Hub line wire. The galvanometer showed no deflection, thus indicating absolute insulation.

THE RIKER ELECTRIC MOTOR CO.

The above company, of 45 and 47 York street, Brooklyn, are now feeling the rush of spring orders, and with the present week have begun to run night and day. They are not only building their well-known slow speed multipolar motors, but are experiencing an active demand for dynamos from 8 lights up to 350. The shops are crowded to their utmost capacity, and Mr. Riker has no complaint to make of the dullness of the season.

A PAMPHLET ON SCHIEREN BELTINGS.

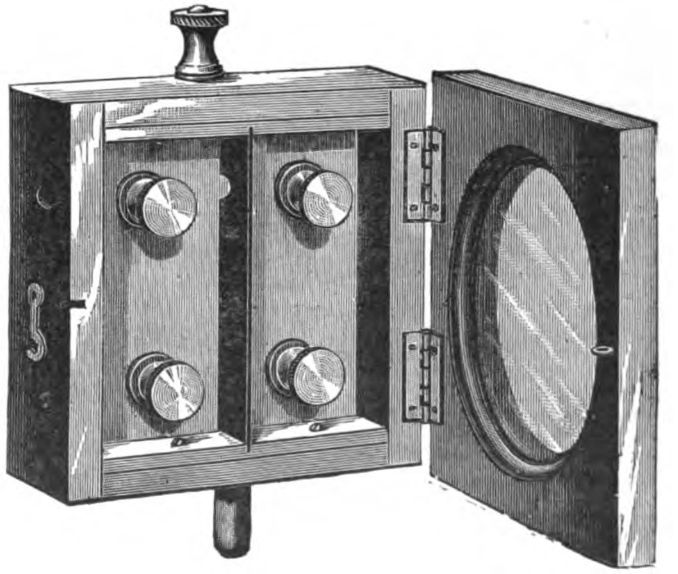
In a handsome blue and white cover, with a cord loop for hanging up at the desk, appears a very useful publication by Chas. A. Schieren & Co., the well-known belt manufacturers, of 47 Ferry street, this city. It contains cuts and descriptions of their electric perforated belts, and of the interesting processes by which it is given its finish and strength. There are also various directions for handling belts, and tables, rules, etc., for calculating horse power, length, etc. After this comes a series of testimonials from electric railways and another from electric light plants, and these are supplemented by a complete cipher code. The whole is very effective and useful.

AMERICAN TECHNICAL PAPERS FOR TURKEY.

Tewfik Bey Eb-uz-zia, Directeur de l'Ecole des Arts et Metiers, in Constantinople, has requested Dr. Cyrus Adler, a commissioner of the World's Columbian Exposition, and an officer of the U. S. National Museum, now in Constantinople, to furnish him with a copy of each of the prominent technical papers published in the United States, and the Museum is now complying with his request. Mr. G. Brown Goode, the assistant secretary of the Museum, has carried out the wish of Tewfik Bey by sending him recent numbers of such papers as would be of use to him, and, it it is hardly necessary to add, has included The Electrical Engineer

THE RUMRILL SAFETY BOX.

The accompanying illustration represents the Rumrill double fusible cut-out box, which is coming into extensive use on electric street cars, as a protection to armatures. The box is six inches square by four deep, and contains two separate plugs, or safety strips, having a capacity of 45 and 65 amperes, respectively. The 45 ampere strip is the one normally used, and, should this blow, the 65 can be switched in, this being the heaviest current that can pass through the motor. The trouble is thus confined to one car, and does not interfere with the rest of the line.



The Rumrill Double Fusible Cut-out.

This device is controlled by Emmet Bros. and Griswold, 150 Broadway.

WESTERN TRADE NOTES.

George B. Foster, formerly of the Thomson-Houston Co., is now with the Illinois Electrical Material Co. as general traveling representative.

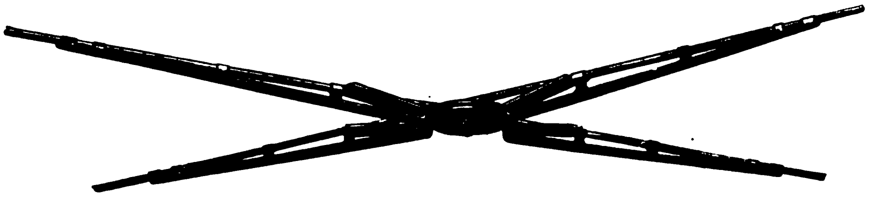
The Riverside Park Railway Co., of Sioux City, Ia., have awarded the contract for all the overhead equipment of their new eight mile road to the Electric Merchandise Company, of Chicago. This contract brought out the sharpest competition from all parts of the country, and the greatest credit is reflected on Mr. A. H. Englund for carrying off the honors in face of such odds.

The Electric Merchandise Co., of Chicago, have a testimonial from the Chattanooga, Tenn., Electric Street Railroad as to their raw hide pinions, which are found "practically noiseless." One set has run 12,000 miles.

THE EMERSON DOUBLE INCLINE ADJUSTABLE CROSSOVER.

Among the novelties lately brought out by the Emerson Electric Manufacturing Co., St. Louis, is a double incline plane crossover, which is illustrated in the accompanying engraving. Four central ribs form the main inclines and four upper plates form auxillary inclines on which the flanges of the trolley wheel travel while passing from the central ribs to the centre plate at the gap. The flanges of the trolley wheel engage with the upper incline plate before passing off the end of the central rib, thus preventing any sudden upward movement of the trolley wheel as as is the case with crossovers as now manufactured.

The inclinations of the upper plate and the central rib are so arranged as to carry any kind of trolley wheels now in use.



The Emerson Double Incline Adjustable Crossover.

Trolley wheels of different systems can pass the crossover with perfect ease. Old trolley wheels wherein the groove is deeply worn can pass as freely as new ones.

The crossover is adjustable to any angle and is applied without cutting or bending the trolley wires and can be reset for any new position such as might be caused by expansion of the trolley wire. The company are also getting out a switch or turnout embodying the double incline plane features.

THOMSON-HOUSTON ELECTRIC RAILWAYS.

The Thomson-Houston Electric Company has just closed a contract for 40 additional cars with the Cincinnati Street Railway Co., of Cincinnati, O., and for 6 cars with the Pueblo City Railway Co., of Pueblo, Col.

During the recent snowstorm in Denver, Col., there was not one cable line in operation, while the Thomson-Houston electric cars were operated without the slightest difficulty. The Denver Tramway Co. has decided to abandon the 18th street cable and use electricity as a means of car propulsion.

The Thomson-Houston Electric Co. has also closed contracts with the Rock Creek Railway, Washington, D. C., for 12 cars; Harrisburg City Passenger Railway, Harrisburg, Pa., for 14 cars; City Electric Railway, Little Rock, Ark., 28 cars; Jefferson Avenue Railway, St. Louis, Mo., for 25 cars; Oxford Lake Line, Anniston, Ala., 6 cars; Allentown & Bethlehem Rapid Transit Co., Allentown, Pa., 15 cars; Marquette City & Presque Isle Co., Marquette, Mich., 3 cars; Braddock & Turtle Creek Railway, Braddock, Pa., 3 cars; Salt Lake Rapid Transit Co., Salt Lake City, Utah, 3 cars; Buffalo Street Railway Co., Buffalo, N. Y., 12 cars; Pittsburgh & Birmingham, 2 cars (making the fourth Thomson-Houston electric railway in Pittsburgh, Pa.); Troy & Albia Street Railway, Troy, N. Y., 20 cars; St. Louis & Suburban Street Railway Co., St. Louis, Mo., 45 cars; Chattanooga and North Side Railway, Chattanooga, Tenn., 4 cars.

CENTRAL ELECTRIC CO.

The Central Electric Company have recently arranged with the Bryant Company to handle their sockets and switches, and already report large sales. They carry a complete stock of all sizes and capacities. The orders for the "Improved Candee" line wire as recently received by the Central Electric Company have taxed to the utmost their facilities for handling a large business, and, in consequence, have tested the factory's capacity to keep them in a large stock of all sizes in anticipation of the spring business. The Central Electric Company are about to place a new carbon battery upon the market, the principal features being the purity of the carbon and the shape of the glass jar, which fits so tightly to the carbon that it makes it virtually air tight and thus prevents the evaporation of the solution.

AN ELECTRICAL PORTRAIT GALLERY.

No one could fail to be interested in, or pleased with, the excellent collection of portraits made by *Modern Light and Heat*, and given in its recent Convention issue. The series embraces 87 pictures, massed together on half a dozen pages of the paper, and the great majority of the portraits are very good, coming out with notable distinctness and fidelity. Mr. Ross is to be congratulated on the success of this electrical "round up," and we beg to acknowledge the courtesy that led him to include in his gallery members of The Electrical Engineer staff.

NEW ENGLAND TRADE NOTES.

The Economic Electric Manufacturing Co. of Boston, have issued a neat little price list of the now well and favorably known "Economic" incandescent lamp. These lamps are made from 10 to 75 candle power and in all colors, mounted in bases to fit the sockets of any standard system, and are of all voltages, from 45 to 120 volts, inclusive. Their prices have been fixed to meet all competition, and are very low, that on 500 lots of 16 candle-power lamps being 80 cents with a discount of 45 per cent. and a rebate of $5.00 per hundred for all returned lamp bases with platinum wires intact. The Economic have made a strong bid for business, and have been very successful so far, having already over 30,000 in use in little more than six months' active business career.

Mr. A. L. Daniels, of the Eureka Tempered Copper Company, of North East, Pa., has been favoring Boston and the East generally with a protracted visit. Tempered copper is now being very extensively used by all manufacturers of electrical apparatus, and Mr. Daniels is exhibiting a very handsome line of samples.

Mr. H. H. Cutler, of Waltham, Mass., well known as a manufacturer of mast arms, lamp hoods and other electric specialties, has decided to go out to Chicago to join Mr. George Cutter, where they will be associated in the manufacture of electrical goods. Mr. Cutler will have full charge of the manufacturing department, his long training adapting him specially for that purpose.

The Thomson-Houston Electric Company.—A standardizing bureau has been formed among the different factories of the Thomson-Houston system. The members are Messrs. Dalzell, of the Schuyler Electric Co., Phipps, of the Brush Co., Talbot, of the Fort Wayne Co., Randall, of the Excelsior Co., H. S. Manning, of the Chicago office of the T.-H. E. Co., Rohrer and Ekstrom, of the Lynn factories, and Lovejoy, of the Boston office. It is standardizing all the various parts in the various factories, meters, cut-outs, switches, switch-boards, lightning arresters, etc.

The Eastern Electrical Supply and Construction Company, of Boston, have imported from France one of the most useful novelties for yachtsmen ever placed on sale in Boston, namely, a musical fog-horn.

By a simple invention the dry battery is made to perform a service which has heretofore been accomplished only by incessant blowing. By the mere pressure of a button a loud and musical blast is evolved, which can be continued at pleasure, giving the man at the wheel complete control of the signals. These horns are made in all sizes, for use on the smallest cat-boat or the largest schooners. By the addition of a series of horns, a blast as loud as a steam whistle can be made; and by putting in circuit a combination switch, a musical scale can be run up and down which is well calculated to "startle the natives."

Mr. H. C. Hawks, lately manager of the New England business of the North American Construction Company, of Pittsburgh, has recently taken over in his own name the whole business of this company in New England, and has bought out their entire stock of tools, apparatus, etc., and will conduct a complete general electric engineering business. He will furnish complete plans, specifications and estimates for central stations and isolated plants, and will carry on a general wiring business. Mr. Hawks has had a long and wide experience in all systems of electric lighting, and has worked in every capacity, so that he brings a thorough practical knowledge of the business to assist him. At a meeting of the Northampton city council last week, the street lighting committee was authorized to close a contract with Mr. Hawks, for lighting the city with about 100 arc lights of 1,200 candle-power capacity. This is to be done for $58.50 a light. Mr. Hawks will continue to make his headquarters, as before, at 620 Atlantic Avenue, Boston.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. MARCH 25, 1891. No. 151.

EICKEMEYER'S DIFFERENTIAL MAGNETOMETER.

BY

Chas. Steinmetz.

"IF you know what kind of iron you have." Everybody knows how often the most exact theoretical calculation of electric machinery is made valueless by this condition of doubt. A short time ago I had the pleasure of listening to a very interesting lecture on the theory of compound-winding of dynamos; everything was considered very carefully and put into equations, so that it became possible to lay out compound dynamos with the highest degree of exactness, "if you know what kind of iron you have." It was this very expression that made me feel sad, just as much as it did, I believe, every other electrical engineer who ever met face to face with the disappointing uncertainty brought into electrical engineering by the unknown properties of the most important magnetic conductor, iron.

In Mr. Eickemeyer's well-known electrical factory in Yonkers, there is an instrument of his invention, which enables the determination of the magnetic properties of iron with a high degree of exactness and in so short a time, that a large number of samples of iron can be tested magnetically in a few minutes.

The principle of this instrument resembles somewhat the principle of the well-known differential-galvanometer, applied to the magnetic circuit. In Fig. 2, suppose F_1 and F_2 were two E. M. F.'s, connected in series; for instance, two cells of a battery, x and y the two resistances which we want to compare. Either resistance x and y is shunted, respectively, by a conductor a and b of equal resistance, which influences a galvanometer-needle G in opposite directions but with equal strength.

Then the zero-position of the needle G shows that the electric current c_a flowing in a is equal to the current c_b in b. But, let the current in x be c_x, and in y, c_y; then we must have:

$$c_a + c_y = c_b + c_x;$$

because the currents c_a and c_y are the two branches of the same integral current as c_b and c_x.

Therefore, if $c_a = c_b$, then,

$$c_x = c_y.$$

But, if $c_a = c_b$, and $a = b$, the difference of potential at the ends of a (or, what is the same thing, y), is equal to the difference of potential at the ends of b or x, and therefore, the current in x and y, and the potential differences being the same, it follows that $x = y$.

That is, this method of connection allows us to compare an unknown resistance x with a standard resistance y.

Now, instead of "electric current," say "magnetic current" or "number of lines of magnetic force;" instead of "electromotive force" or "potential difference," say "magnetomotive force;" and, instead of "electric resistance," say "magnetic resistance," and we have the prin-

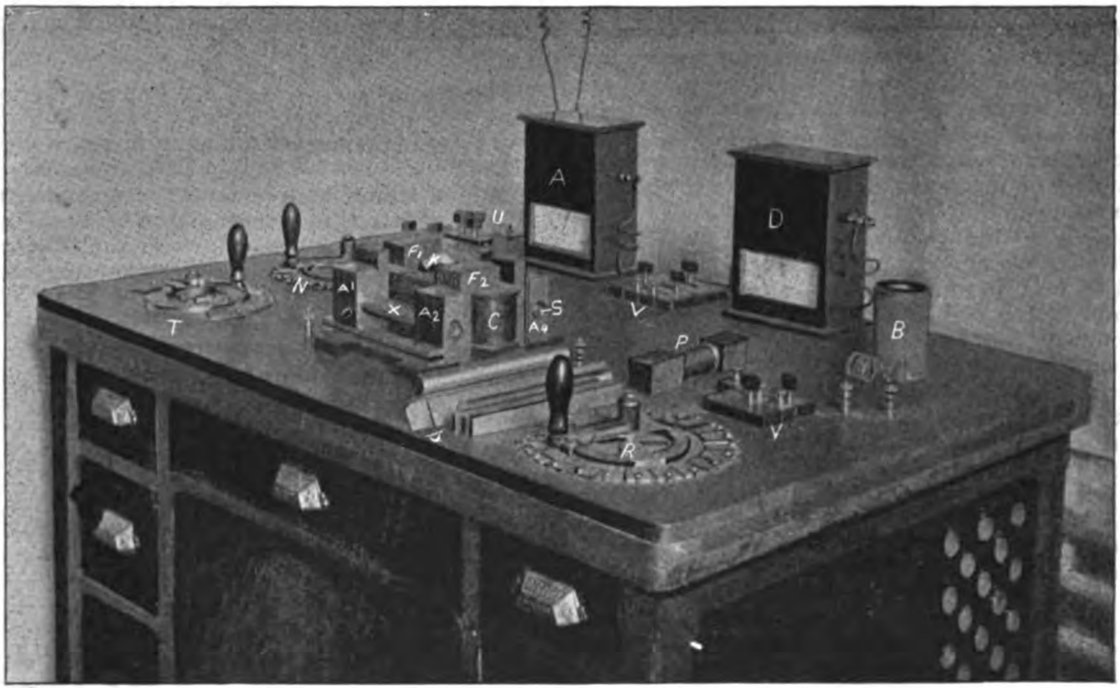


FIG. 1.—EICKEMEYER'S DIFFERENTIAL MAGNETOMETER.

ciple of Eickemeyer's magnetic bridge, or differential magnetometer.

Indeed, for electric measurements, only one electromotive force F would be sufficient. But the air being a magnetic conductor, also, the use of two equal magnetomotive forces in series at two diametrical points of the magnetic circuit is necessary to keep the opposite points of the circuit at the same magnetic potential.

The magnetic circuit of the Eickemeyer differential magnetometer consists of two pieces of best Norway iron, ⊔⊓-shaped, shown in the illustration of the complete instrument, Fig. 1, and in the diagram Fig. 3 at F_1 and F_2. The middle portion is surrounded by a magnetizing coil C. Therefore, if coil C is traversed by an electric current, the front part s_1 of the left iron piece becomes south, and the back-part n_1 north polarity; the front part of the right iron piece n_2 becomes north, and the back part south; and the lines of magnetic force travel in the front from the right to the left, from n_2 to s_1; in the back the opposite way, from the left to the right, or from n_1 to s_2, either through the air, or, when n_2 and s_1, or n_1 and s_2 are connected by a piece of magnetizable metal, through this and through the air.

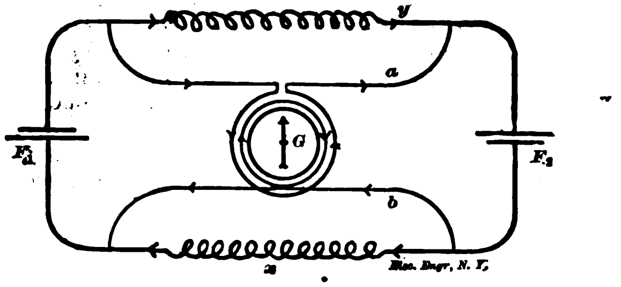


FIG. 2.—EICKEMEYER'S DIFFERENTIAL MAGNETOMETER.

In the middle of the coil C stands a small soft iron needle with an aluminum indicator, which plays over a scale K, and is held in a vertical position by the lines of magnetic force of the coil C itself, deflected to the left by the lines of magnetic force traversing the front part of the instrument from n_2 to s_1, deflected to the right by the lines traversing the back from n_1 to s_2. This needle shows by its zero position, that the magnetic flow through the air in front from n_2 to s_1 has the same strength as the magnetic flow in the back from n_1 to s_2 through the air.

Now we put a piece of soft iron x on the front of the instrument. A large number of lines go through x, less through the air from n_2 to s_1; but all these lines go from n_1 to s_2 through the air at the back part of the magnetometer, the front part and back part of the instrument being connected in series in the magnetic circuit. Therefore the needle is deflected to the right by the magnetic flow in the back of the instrument.

Now, we put another piece of iron, y, on the back part of the instrument, then equilibrium would be restored as soon as the same number of lines of magnetic force go through x, as through y, because then also the same number of lines go through air in the front as in the back. As will be noted, the air here takes the place of the resistances a and b, influencing the galvanometer needle G, as in the diagram, Fig. 2.

The operation of the instrument is exceedingly simple and is as follows: Into the coil C an electric current is sent which is measured by the ammeter A, and regulated by the resistance-switch R. Then the needle which before had no fixed position, points to zero.

Now, we lay the piece of iron, the magnetic properties of which we want to determine, on the back part of the instrument. The needle is deflected to the left. On the front of the instrument we put Norway iron rods of known cross-section and known conductivity, until equilibrium is again restored. Then the iron in the front has the same magnetic resistance as the iron in the back, and the ratio of the cross sections gives directly the ratio of the conductivities; so that by a single reading the magnetic conductivity of any piece of iron can be compared with that of the Norway iron standard.

For absolute determinations, the iron is turned off into pieces of exactly 4 square centimetres cross section and 20 centimetres in length, as shown at X and S, in Fig. 1, both ends fitting into holes in large blocks of Norway iron, A_1, A_2, A_3, A_4, which are laid against the pole pieces S, N, of the magnetometer, so that the transient resistance from pole face to iron is eliminated.

An example may show the operation more clearly: A piece of very good annealed cast steel is laid into the blocks A_1, A_2, in the front of the magnetometer. It has the usual size of 20 centimetres length and 4 square centimetres cross-section. An equal rod of best Norway iron, the standard, S, is put on the back of the instrument. The needle is deflected from zero, but not much; the cast steel is very good. To bring the needle back to zero, we have to add in the front .2 square centimetre of Norway iron.

Therefore, 4 square centimetres of Norway iron have the same magnetic conductivity as 4 square centimetres of this cast steel + .2 square centimetre Norway iron, or:

4 sq. cms. of cast steel = 3.8 sq. cms. Norway iron; that is, the magnetic conductivity of this kind of cast steel is as high as 95 per cent. of that of Norway iron!

We now change the magnetizing current in C, decreasing it from 7.5 to .5 ampere. We now have to add .5 sq. cms. of Norway iron to restore equilibrium. Therefore, for very low magnetization the magnetic conductivity of this cast steel is only $= \frac{35}{40} = 87.5$ per cent. of Norway iron. For high magnetization it increases up to 96 per cent.

To get rid of the remanent magnetism, a reversing switch T allows us to reverse and to break the current in C.

Such a determination is done very quickly, and permits, in half an hour, of testing a large number of samples of iron, delivered from foundries, etc., to choose the iron best suited for the intended use, and not to buy "a pig in a poke."

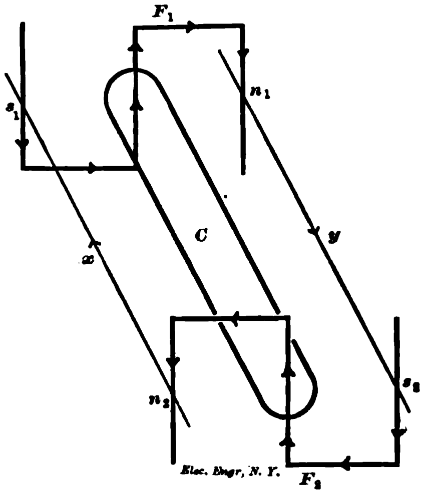


FIG. 3.—EICKEMEYER'S DIFFERENTIAL MAGNETOMETER.

To determine the intensity of magnetization in the iron, that is, the number of lines of magnetic force, the coil B, of a known number of turns, is slipped over the standard magnetic resistance S, and the current in C, that is the magnetism, reversed. The reversal of magnetism induces an electromotive force in the coil B, which is measured by the throw of the galvanometer-needle in D, and gives the exact number of lines of magnetic force in the standard.

This magnetometer is us Mr. Eickemeyer's factory with the greatest success for the determination of the field magnet iron in the dynamo machinery in the following way: On the very iron frame of the dynamo or motor, which constitutes its magnetic field, is cast a square piece of iron 8 inches long and 1¼ inch square. This is broken off, turned off in the middle for a length of 4 inches and to 1⅛ inch diameter, and placed on one side. Such a piece is shown in Fig. 1, at P.

This piece of iron is compared in the magnetometer with the Norway iron standard, and thus gives for each machine the magnetic properties, not only in general, of the kind of iron used, but of the very casting which constitutes the dynamo field. By means of this the field winding is determined; more can hardly be expected.

I need not remark, that by testing a very large number of different sorts of cast iron and steel, many interesting results are found; for instance, that for cast iron with very low magnetization the conductivity is often as low as 30 to 40 per cent. of Norway iron, but increases with increasing magnetization up to 80 per cent. and more. Some kinds of annealed steel are even better than ordinary wrought iron; one sample attained for average magnetization, (7.5 amperes) 97½ per cent. of Norway iron.

The indicator needle, in the middle of the coil C, is closely surrounded by a small coil E. This, when excited in the opposite direction to the main coil C, decreases its directing force and thereby increases the sensitiveness of the instrument, which is very useful for high magnetization where the directing force of C is very great. This "astatic coil," when kept excited in the same direction as the main coil C, after the current in C is broken, affords the means for determining remanent and permanent magnetism by the coil B. This coil B is slipped over the standard resistance S, at the other side of the bridge, being the sample of iron to be tested for its hysteresis. Then, after breaking the main current in C, the needle is directed only by the coil E, which has no influence upon the magnetic circuit of the magnetometer, and therefore the needle is deflected by the remanent magnetism. Now the needle is brought back to zero by a current in coil B, and this current, measured by ammeter D and regulated by the resistance switch N, gives the magnetomotive force of remanent, or, when a permanent magnet is used, of permanent magnetism. At *s* are shown pieces of Norway iron of known cross section, used as fractional standard resistances.

One Norway iron standard, exactly like S is cut into two pieces, well fitted to each other, which, when withdrawn, leave a gap between them, for testing sheets of different materials or even liquids brought into the gap or air spaces.

For instance, if an air gap of $\frac{1}{32}$ inch is left between the two pieces of Norway iron, then the magnetic conductivity for very low magnetization is decreased by this air gap to only about 20 per cent. of the unbroken standard S, but increases for increasing magnetization, until, for very high magnetization, this air gap has almost no influence upon the magnetic circuit. This, from the known saturation curve of the Norway iron standard, allows of determining the magnetization (the number of lines of magnetic force) by means of the behavior of air gaps, without always going back to the use of the ballistic galvanometer. And thus a large number of applications of this instrument for magnetic tests have been made; still more can be devised, into which I cannot enter more deeply here, having sufficiently shown its usefulness, I believe.

The lower part of the desk, upon which the instrument is mounted, contains accommodation for a storage battery for giving the exciting current. Terminals U allow a current to be sent in from outside, as is often more convenient in an electric factory. Switches and cut-outs V regulate and control the different circuits, and the back part contains the resistances, so that the instrument, with the desk upon which it is mounted, is entirely self-contained.

THE ENTZ ELECTRIC RAILWAY SYSTEM.

THE novel electric railway system shown in the accompanying illustrations was devised by Mr. Justus B. Entz, of this city, and consists in the employment of a continuous stationary armature, which extends from end to end of the track. The armature exercises its force upon a field magnet, which is carried by the car with the aid of brushes that also travel at the same rate as the car, and that convey the current from mains, which are laid along the route, to that portion of the armature which is under the influence of the field-magnet.

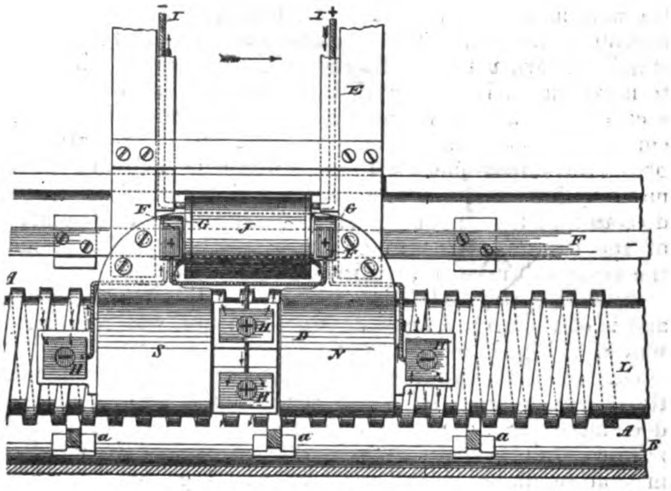


FIG. 1.—THE ENTZ ELECTRIC RAILWAY SYSTEM.

As will be seen, the armature A is a continuous coil occupying the entire length of the conduit. The field magnet D is suspended within the conduit from the car and embraces the armature as shown in Fig. 2. The mains E F are secured within the conduit, and extend from end to end of the road. The contact pieces G G are carried by the magnet D, and bear against the mains, while the brushes H H are carried by the field magnet, and bear upon the outside of the coiled armature.

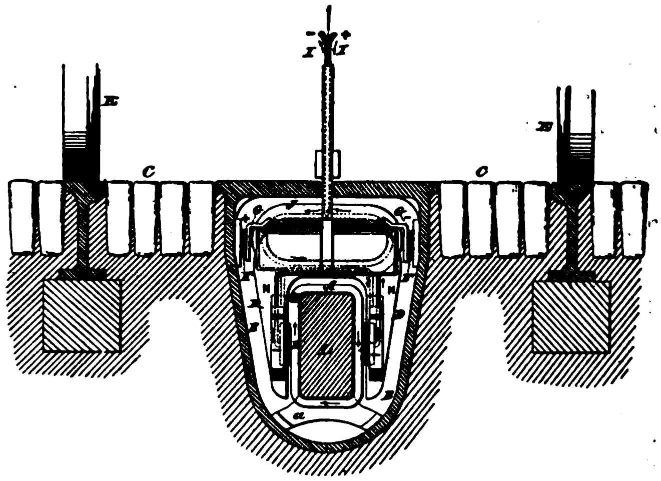


FIG. 2.—THE ENTZ ELECTRIC RAILWAY SYSTEM.

The magnet D is excited by the aid of the conductors I I that lead from the car to and around the spool J of the magnet. The winding of the armature A is that of a continuous coil upon an iron core, and corresponds to a Gramme ring armature cut at one place and laid out straight. The field-magnet has a single coil on its spool, and its pole-pieces from either end extend down and embrace the top and sides of the armature. The poles are of opposite polarity, as indicated by the letters N S, it being necessary that the current should flow in opposite directions in that portion of the armature which is inclosed by each set of pole-pieces. To this end the brushes are placed and connected as shown, a brush of one sign, say +, being between two poles and between two brushes of the opposite sign, say—, of which there is one at each end of the magnet. With the brushes connected in this way the current will enter at the middle + brush, divide and flow in opposite directions under the opposite poles to the outside brushes.

The effect of the current flowing in the armature upon the field-magnet is to cause the one which is capable of moving to move in relation to the other, and as in this instance the armature winding is fixed the magnet will tend to move and will carry with it the vehicle to which it is secured, and as the current in the armature coil is kept continually beneath the magnet by means of the traveling brushes, the movement will be continuous, and this movement will be in either direction at will, according to the direction of the current in the winding, and the polarity of the magnet. Changing either and keeping the other the same will reverse the direction of motion.

An iron core L is placed within the tubular armature, and is of the same length as the armature, which is represented in Fig. 2, in cross section.

One of the advantages claimed for this system is that the power applied is in the nature of a direct pull, and does not depend upon the weight of the car for its traction power. Another advantage is that the armature winding may be regulated to suit the traffic as regards speed and power along different parts of the same route. Thus, on a grade, the windings may be closer together than on the level, giving a greater average efficiency. It is also evident that all conductors carrying dangerous currents can be completely sealed in conduits which admit of no mechanical or electrical communication with the street or car, which may be propelled in either direction upon the same track, and the speed regulated at will.

THE INFANCY OF ELECTRICITY.

BY

Edwin J. Houston

It may interest the readers of The Electrical Engineer to know that the book referred to by Prof. Sweet in his interesting communication, entitled the "Infancy of Electricity,"[1] is not a cyclopedia of the sciences, as suggested, but is the last paragraph of the introduction to a work entitled "A Complete Treatise on Electricity in Theory and Practice, with Original Experiments," by Tiberius Cavallo, F.R.S.

Cavallo's book is in three volumes of between 300 and 400 pages each, and is, probably, the most complete work issued on early electrical science. The copy in my possession is the fourth edition and was published in London, in 1795. The third volume was added since the publication of the third edition. It is probable, therefore, that the date assigned for the first appearance of the statement of Prof. Sweet, viz., in 1785 or 1789, is correct.

Cavallo, in speaking of the discovery of the Leyden phial in 1745, says: "Then, and not till then, the study of electricity became general, surprised every beholder, and invited to the houses of electricians a greater number of spectators than ever before assembled together to observe any philosophical experiment whatsoever."

Then follows the matter quoted by Prof. Sweet: "Since the time of this discovery," etc.

I have been using the quotation referred to as an illustration in my lectures for some years past, and have now given the exact title of the work, believing it may be of general interest.

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[1] See The Electrical Engineer, March 4.

SAFETY AND AESTHETICISM IN CONVERTER INSTALLATIONS.

BY

G. T. Evans.

It seems scarcely more than yesterday that this subject would have been abortive and absurd. But to-day, when the converter has spread over the country and is multiplying at a rate that an English sparrow might well envy, a few words in relation to the matter may not be inopportune. Though there are sharp breezes in the scientific air of "light without heat," and manufactured fire-flies may appear at any moment, it is probable that the converter will occupy the field for some length of time.

It is therefore assumed that its installation should be made in the most substantial manner, and not, as is often the case, as if it were to have a mere butterfly existence. In this connection the placing of converters on poles is to be avoided. Poles do not last forever, and their life is not augmented by being top loaded with heavy converters. But if poles are used for the purpose the converters should be hung on the cross arm by flat iron hooks. Bolts or lag screws not only weaken the cross arm but their employment makes the installation and any future change or removal more than doubly difficult.

The usual way of fastening converters to walls of buildings is also open to objections. Simply securing by screws to wooden walls or plugs driven into masonry is doubtless safe enough for a time, if the screws have a solid hold; but I would not care to spend a score of years under converters thus put up; and it is likely that my life insurance agent would object as strenuously to this arrangement as his brother of the fire department does to the unsoldered joint. A converter hung securely from a medium large galvanized iron bolt, passing nearly or entirely through the wall, is practically safe for almost any time. It also possesses the advantage of being easily exchanged when necessary. Insulators can be applied as customary, the screws for these merely entering the wall to hold the converter from swinging.

From a purely aesthetic point of view the converter is by no means a beautiful object, and it is not to be wondered that people object to have these "stoves" and "coffee mills" stuck conspicuously on their property. Very often it is impossible to place a converter except on the front wall of a man's building. If such a disposal is unavoidable, the constructing engineer should make the best of the situation and not add to the scene by a superfluous number of wooden brackets and unnecessarily large wire. Iron brackets should be used at all times when unsightliness is to be avoided. But, where possible, the converter should be hidden or put out of sight as far as it can be.

Locating them around corners or behind bay windows and wings has a pleasing effect of absence. But when at all feasible, put the converter within the building. Here, if properly placed, it will give the least trouble, be easy of access (converter fuses *do* give out sometimes) and be not so dangerous as a box of matches. The hypercritical fire underwriter will become educated to this truth sometime and will no more require a converter to be hung on the outside of a building than he now does a cook stove or a tallow candle.

Crawfordsville, Ind.—A temporary injunction has been issued forbidding the city of Crawfordsville from purchasing an electric light plant. H. S. Braden applied for the injunction as a citizen and taxpayer, but it is generally understood that he represents other parties. The reasons assigned by the petitioner are that the city has no right to do commercial lighting, and that the resolution passed by the council to buy a plant is invalid because the Mayor cast the deciding vote.

STORAGE TRACTION ON THE LEHIGH AVENUE RAILROAD AT PHILADELPHIA.

The recent withdrawal of the storage battery cars from the Lehigh Avenue Railroad in Philadelphia, has given rise to numerous inquiries as to the causes which have led up to this event. This being the case, a brief statement of the conditions involved and of the results actually obtained will be of great interest at the present moment, when the demand for storage traction is more emphatic and evident than ever. In the first place, only four cars were in regular commission on the road. It is evident, therefore, that the fixed charges alone were so great that a dozen cars might have been operated with the same, or very little increase in, expense. Again, the road was so situated that the traffic which existed was but very light and even then subject to very great fluctuations between winter and summer months. To this we must add the fact that the road presented a succession of grades and curves which were a tax of the most serious nature upon the storage batteries.

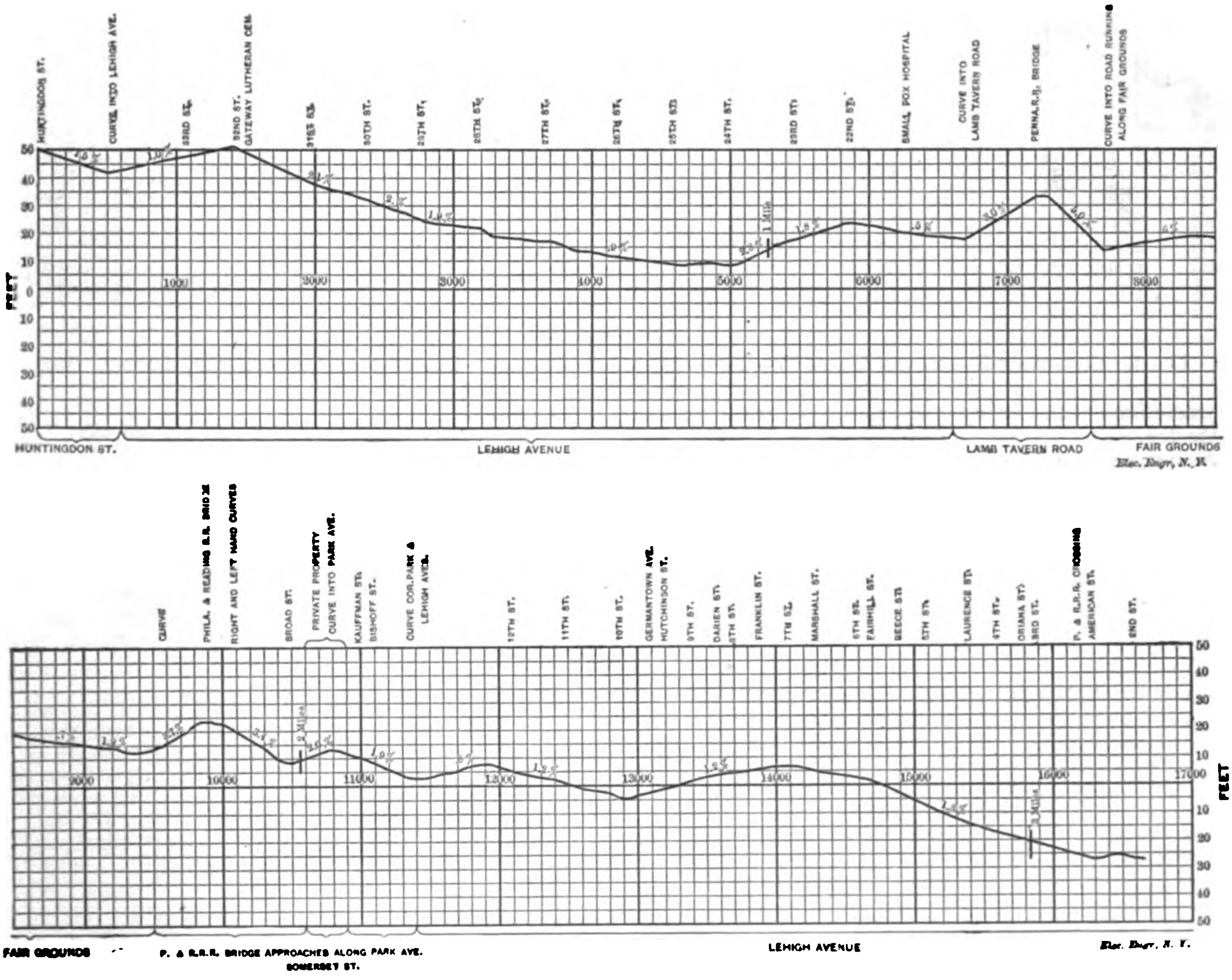


FIG. 1.—PROFILE OF LEHIGH AVENUE RAILROAD, PHILADELPHIA, PA.

It has given opportunity of making observations upon this class of traffic, which are of the highest importance and which go to prove that with proper conditions storage battery traction can be successfully undertaken by street railways. A glance at the profile of the road, shown in Fig. 1, will give at once an idea of its character. In a length of 3.15 miles it embraces a large number of curves, and grades reaching as high as 5 per cent.; there being, in fact, scarcely a level spot on it, and the terminal of the road being 75 feet below the starting point in level. The cars employed weighed 4,500 pounds, empty, and with the batteries 15,000 pounds; this without passengers. With the passengers, therefore, the total weight was between 9 and 10 tons. Only two sets of batteries per car were employed, and with three cars on the road the round trip was made in 57 minutes, covering a distance of 6⅛ miles; while with four cars, 60 minutes were allowed per round trip. The road was operated electrically between May 1 and January 16, covering a total running time of 37.28 weeks; the total number of miles run was 52,271 and the number of passengers carried, 336,454; and in order to give an idea of the fluctuation of traffic mentioned above, we give below the number of passengers carried in July and August, 1890:

	Total.	Daily Average Exc. Sundays.	Sunday Average.
July,	58,650	1,736	3,818
August,	59,890	1,514	4,104

From this, it will be seen that the daily average of passengers over the road amounted in August to only 1,514, while the Sunday averages reached 4,104, and upon these days the average load was between 12 and 15 tons, and subsequent months show even a much larger falling off in traffic than those given above. This was due to the fact that the road was principally patronized by people traveling to Fairmount Park, and naturally the approach of winter caused a large diminution in this traffic.

As we have stated above, the road has given excellent opportunities for observation and as a proof of this we need only compare the results obtained and the improvements made as the work progressed. Thus, in Fig. 2, is given a chart showing the records made on Sunday, Aug. 31, 1890, which was one of the heaviest traffic days on the road. Here, it will be seen, the electrical energy in horse power, taken from the batteries, which are represented by curves in full lines, fluctuated enormously, as did, of course, the amperes drawn from the cells. The fluctuation in voltage of the cells shown in the upper curve is also characteristic of the heavy duty to which the cells were subjected.

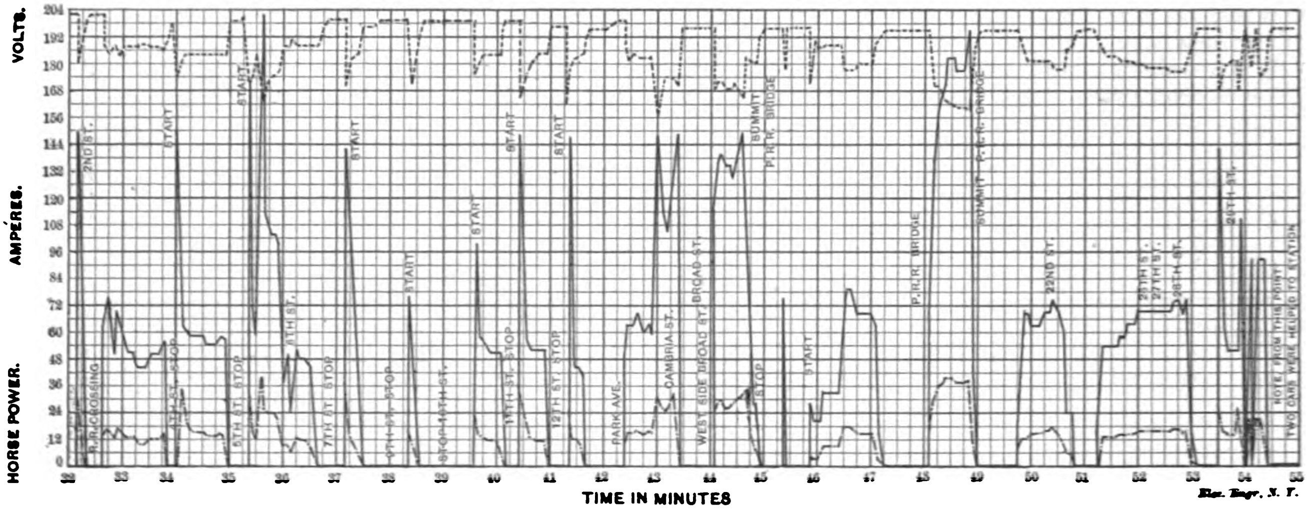


FIG. 2.—CURVES OF ELECTRICAL HORSE POWER, CURRENT AND VOLTAGE.—OBSERVED ON STORAGE CAR, AUGUST, 1890.

As many as ten trips per day, were run, representing 63 miles; on some occasions with one charge of the hundred cells of battery employed.

With the improvements which were made as the result of observation, the character of the work was materially improved. This is admirably shown by the chart, Fig. 3, which gives the result of a similar set of observations made on Oct. 15, 1890. This was also made with a fully loaded car, and, as will be seen, the fluctuations in the current are not nearly so violent, and, as a result, the energy drawn from the battery shows a large diminution, indicating the efficacy of the improvements introduced. These improvements consisted, in the first place, in the motors and in the batteries. Each car was equipped with two motors, and the experience gained has shown almost conclusively that a higher general average efficiency can be obtained by commutating the motor than by commutating the batteries, in order to obtain the varying powers required for operation.

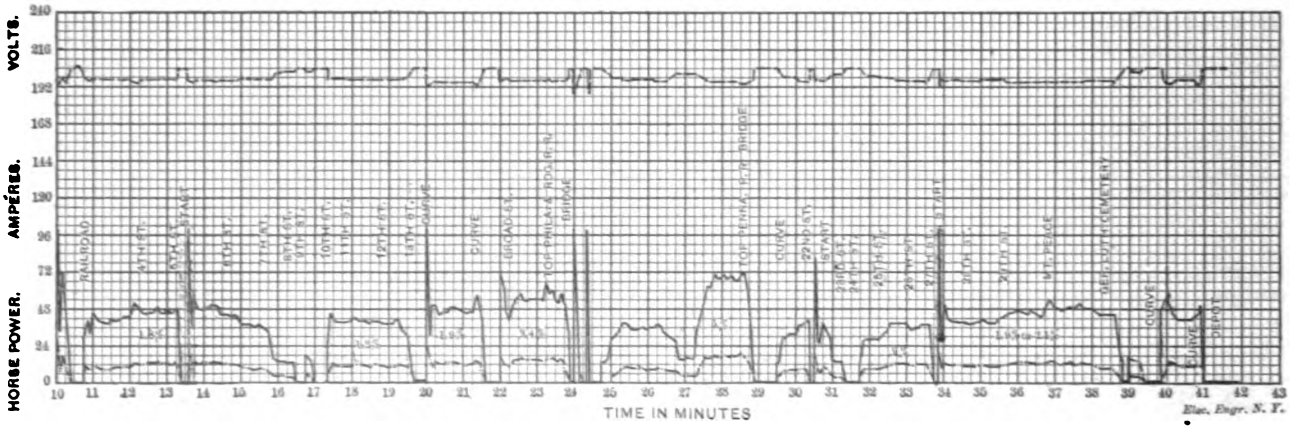


FIG. 3.—CURVES OF ELECTRICAL HORSE POWER, CURRENT AND VOLTAGE.—OBSERVED ON STORAGE CAR, OCTOBER, 1890.

The results obtained and graphically indicated in chart, Fig. 3, are given in the following table:

Distance	3.15	mile
Time per trip	31	minutes
" of discharge	26½	"
Weight carried	8.5	tons
Discharge Rate:	100	amperes
Maximum	70	
Mean	40	"
Mean per ton	4.7	"
E. M. F.:		
Maximum	205	volts
Minimum	192-188	"
Mean	196	"
Ampere Hours:		
Total	17.9	
Mean per mile	5.69	
" " " per ton	0.67	
Horse Power:		
Maximum	18.4	
Mean	10.48	
" per ton	1.15	
Horse Power Hours:		
Total	4.65	
Mean per mile	1.47	
" " " per ton	0.17	

Further experiments made show that the results even here obtained could be improved upon, and subsequent experiments showed that the mean horse power per miles with a heavy load over this road did not exceed 1.25, while with a light load it formerly amounted to 1.3.

Worm and worm wheel gears were employed on these cars to connect the armature shaft with the car axle.

This method of gearing has, in the past, been criticised, as involving a large loss through friction, but the results obtained on this road have shown conclusively that, when properly designed, this method of gearing is not only highly efficient, but possesses other unquestioned advantages. As illustrative of the high efficiency of this form of gear we give in Fig. 4, the results obtained in a series of tests of a worm and worm wheel made by the Electric Car Company of America. The ratio of the worm to worm wheel was 1 to 8. With this arrangement the curves show that the efficiency above 300 revolutions ranges between 80 and 90%. This fact, it will be remembered, bears out the statements made by Mr. Anthony Reckenzaun, in a paper read by him before the American Institute of Electrical Engineers, in September, 1887, and which led him to prefer this form of gearing to all the others which he discussed at the time. The storage batteries with which the experiments on the Lehigh Avenue road were made, were those of the Electric Storage Battery Company.

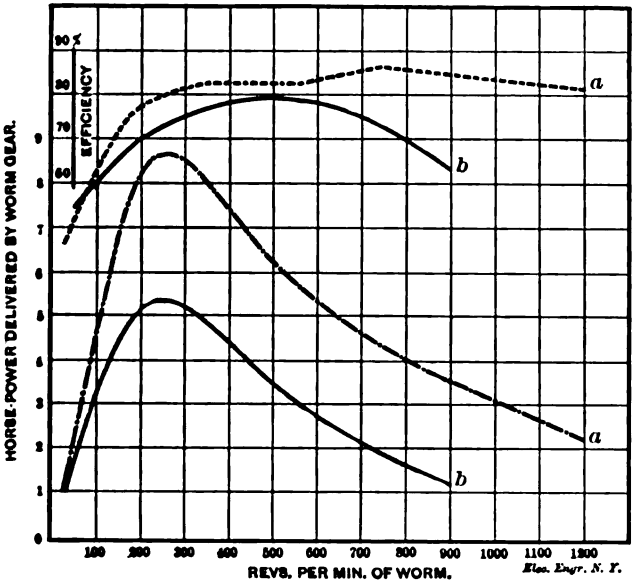


FIG. 4.—CURVES SHOWING TEST OF WORM GEAR.

For some more recent tests of the worm gear used on the Lehigh Avenue Railroad at speeds equivalent to between 5 and 10 miles an hour of the car, the mean efficiency was 82 per cent. with a mean of 12 mechanical horse-power on the axle. The maximum efficiency was 85 per cent. at 550 revolutions of the armatures (equal to about 5½ miles an hour of the car), giving 15 mechanical horse-power on the axle, the ratio of revolutions of armature to axle being 8 to 1.

Although financial reasons dictated the withdrawal of the electric cars from the road, the admirable records kept, of every detail of operation, show that the outlook, far from being discouraging, is of the most hopeful character, and that it is only a question of operating storage cars under suitable conditions, to make this method a commercially successful one.

ELECTROLYSIS IN WATER SOFTENING.

For softening water by means of hydrated oxide of lead cheaply, it is necessary to obtain the oxide, and the following method has been devised by M. Villon. A solution of sodium nitrate is placed in a vat divided into two compartments by a diaphragm; lead electrodes of large surface are placed in the solution and the current from a dynamo then passed through. The sodium nitrate is decomposed, caustic soda being formed in the negative compartment and nitric acid at the positive pole, from which it dissolves a certain quantity of lead, forming lead nitrate. When the current has passed through the liquid for a certain time, the solutions are run from the two compartments into a second vat and there mixed by means of an agitator. The soda precipitates hydrated oxide of lead and itself forms sodium nitrate; the solution is then filtered and the nitrate solution again submitted to electrolysis.

AN ANALOGY BETWEEN THE MAGNETIC AND VORTEX RING FIELD.

BY

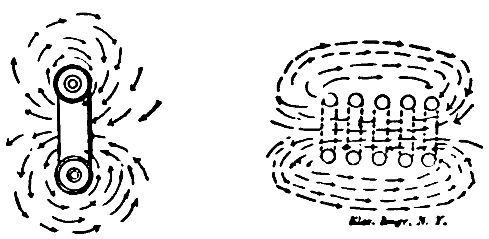
A. E. Dolbear

In the editorial in THE ELECTRICAL ENGINEER for March concerning my paper on "Change of Form Affecting a Magnetic Field," the remark is made that "the assumption of the ring form for a magnetic molecule makes it difficult to reconcile this theory with the observed phenomena of magnetic polarity;" and this leads me to the attempt to point out a curiously close analogy, if nothing more, between the magnetic *field* and the vortex ring *field*, if one may employ such an expression.

Imagine a simple vortex ring, and consider the direction of the rotations that constitute it a ring. All the motions are inward on one side and outward on the other. Looked at in cross section in a plane parallel to the axis of the ring it appears as in Fig. 1, these outgoing and incoming lines being exactly like the pictured lines of force of a magnet.

The effect of the rotary motion upon the circular axis extends to quite a distance beyond the boundary of the material that is actually rotating, as may be shown by making such rings in any convenient way and noting their behavior when they are in proximity to each other or to other objects. For instance, a swift moving vortex ring four or five inches in diameter, if started *parallel* to a surface, as of a table, will be sure to move towards the table and break upon it even at the distance of six inches or more, following a path as an ordinary ball does when thrown horizontally. Also, two such rings, if moving towards each other in the same straight line, will have their movements visibly retarded before they collide, acting, therefore, as if they mutually repelled each other. This shows that they have a *field*, or a space outside of their actual body, in which their motions induce some sort of a stress.

As the actual rotations are inward on one side, and outward on the other, it follows that *the properties of the two sides of the ring are unlike.*



FIGS. 1 AND 2.

Now, imagine that two, or more, such rings were arranged upon the same axis as in Fig. 2, so that all their similar faces are turned one way; then would this external field be represented by precisely the same set of lines that are pictured about a straight bar magnet. Its opposite ends would possess different proportions, mutually repelling similar ends and attracting dissimilar ends, as do magnets. Now, when one recalls the fact that what knowledge we have of magnetism goes to prove that magnetism must be a property of some molecules, if not of all, and that it is generally agreed among physicists, that what is called polarity in a body is simply the combined effect of having all the molecules facing one way, so as to make the *fields* of the individual molecules simply additive, it will be seen how close the phenomena of vortex rings come to the phenomena of magnetism.

I do not mean to assert anything as to their identity, but only to point out a simple and easily understood mechanical analogy between them.

If, to go one step further, one could imagine a current of electricity to be circulating around this ring circuit, he would at once have the exact condition for a magnet, and a magnetic field. This, indeed, was the idea in Ampère's theory of the magnet, but applying it to the vortex ring gives to it a degree of definiteness it did not possess before, and what we have been sadly lacking in, in dealing with the questions of electricity and magnetism, is machanical conceptions of atoms and molecules that would lend themselves in any degree to such phenomena.

SILICON BRONZE WIRE FOR ELECTRIC RAILWAY CONSTRUCTION.

BY

Frank J. Stone

In building an electric railroad, the engineer will naturally endeavor to make his overhead construction as light, strong and symmetrical as possible, both for the sake of appearance and durability. In selecting a trolley wire, therefore, he must look for strength, durability, conductivity, non-corrosion and ductility, combined in the highest degree, and if one of these properties is in the least deficient, it must be reinforced in some way. Silicon bronze wire stands at the head of the list of metals in strength, durability, non-corrodibility and ductility, and is only slightly deficient in conductivity, out-ranking every other metal or alloy used in electrical construction except copper. How shall we make up for this single deficiency?

One of the most eminent electrical engineers in this country quickly overcame the difficulty by using copper feed wires for carrying the current, and making the silicon bronze wire a contact or trolley wire only. In this way the extra resistance of the silicon bronze would occasion absolutely no loss of current, and as the electrical capacity of the trolley wire is sufficient to carry the current for all cars that would ever be between two in-feeds, there is no danger of overheating.

This feeder system then solves the problem in a most satisfactory manner. By the use of feeders we not only entirely overcome the sole objection to the use of silicon bronze, but at the same time provide for an absolute maintenance of electrical pressure the full length of the line, no matter how the cars may happen to be distributed. If, by accident, the trolley wire should be broken, the cars located beyond the break will receive their current through the feeder wire, just the same as if there had been no accident to the trolley wire.

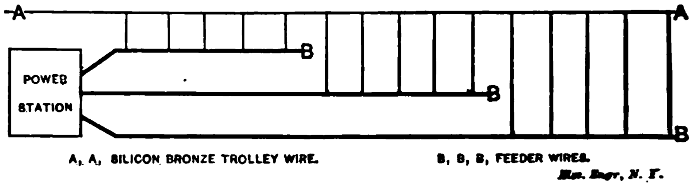
We can summarize the advantages of silicon bronze wire as follows: First, a tensile strength of 80,000 lbs. per square inch, which is nearly twice that of large diameters of hard drawn copper wire. Second, a ductility of 30 to 35 twists in 6 inches on a No. 4 B. W. G. wire. This far exceeds the standard of any other metal of equal strength and diameter. Third, great resistance to wear, as a 6½ mile road operated since construction equivalent to 800,000 car miles, shows no appreciable wear on straight away track. Fourth, absolute resistance to corrosion, which insures a perfect contact, even where the wire is used in mines and under other similar trying conditions. Fifth, freedom from breakage by surface abrasion, a frequent source of trouble with hard drawn copper wire.

As against these excellent qualities may be placed the seeming disadvantages of its higher resistance than copper; this is, however, entirely overcome by the system of feeders before mentioned.

Silicon bronze wire has a conductivity equal to about one-half that of hard drawn copper wire, so that in estimating the quantity of wire required for an electric road, it is only necessary to consider the trolley wire as being one-half its actual size; in other words, according to the best accepted methods of construction, where a No. 4 B. W. G. silicon bronze trolley wire is used, it should be calculated as having the capacity of a No. 8 B. W. G. copper wire, and the feeder wires must be given sufficient sectional area to carry the electrical energy required, less this amount.

The accompanying diagram shows not only the method by which the lack of high conductivity is perfectly compensated for, but also shows how the potential is maintained throughout the whole length of the line, even to portions of the road remote from the power station. As the feeders are not tapped before reaching the point where the power is to be used, and can be thoroughly insulated over their entire length, we can count upon charging the trolley or contact wire at any point with its full potential, namely, 500 volts.

In the matter of appearance, the silicon bronze wire is of great advantage in the construction of electric roads, for we are able to use a small wire on account of its high tensile strength. Practice shows that a wire .238 inch in diameter and weighing but 905 lbs. per mile has sufficient strength and conductivity. This wire has the capacity of supporting almost two tons actual weight, and on account of its small diameter and strength can be drawn much more taut than copper wire. This fact alone gives the line a well proportioned appearance, doing away entirely with "clothes line sag" so noticeable when hard drawn wire is used.



Silicon Bronze Trolley Wire with Feeders.

The entire overhead construction is also lighter, as we have to support a wire weighing only 905 lbs. per mile instead of one weighing often over three times as much.

The feed wires carrying the current are placed on the poles at the sides of the street, where their weight can be easily supported, and where they are practically out of sight. Especially is this the case when the road runs through the resident portions of a city and among trees. In many localities the feeders can be carried up side streets and alleys, thus making a large saving in the lengths of the conductors and removing all superfluous overhead construction from the principal streets on which the road is built.

As the extra resistance of the silicon bronze trolley wire is entirely overcome by the use of feeders, and, therefore, does not occasion the slightest increase in the consumption of coal at the station, all possible objection to its general use is completely removed, and on account of its many superior qualities, it has already been adopted by a large number of our leading electrical engineers.

TELEGRAPHERS MUST LEAVE THE ORDER.

By order of General Manager Clark, of the Union Pacific, all telegraph operators of that line in Colorado have been notified that they must sever their connection with the Order of Railway Telegraphers or leave the service of the company at once.

THE EVANS SYSTEM OF DRIVING DYNAMOS.

BY

Henry T. Conant

One of the many mechanical problems which present themselves to an electrical engineer in designing an electric plant, relates to the transmission of power to the dynamo. In many instances, owing to size or shape of available space, this is a very perplexing question and may be considered of enough importance to warrant a short discussion of the principles involved in two of the more common methods now in use.

The transmission of power by ordinary belting has been made the subject of so much experimental study by eminent engineers, that we are fortunately in possession of a great deal of reliable data, from which can be established standards for comparison under various conditions which may be imposed.

From the published results of a large number and variety of such tests, and the well-known principles upon which they are based, it has been pretty definitely determined under what conditions a belt must be used to give the best (most economical) results, and what, under these conditions, are the tensions in each side of the belt—the power that it can carry without undue slip or strain—the pressure exerted on the bearings, and the coefficient of friction necessary to maintain these conditions.

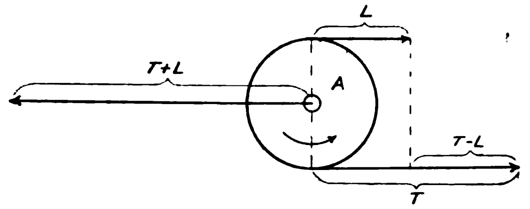


FIG. 1.

Rope transmission, link belting, and other similar methods, all depend on the same principles, and are subject to the same laws as ordinary belting, and, although their efficiences may not be the same, the type to which they belong is a distinct one, and may be fairly represented by good double oak tanned leather belting.

Direct coupling, as a method of transmission, is certainly most efficient, but as a method of driving dynamos of comparatively small capacity is, for many reasons, undesirable. Inasmuch as the questions involved in its use are chiefly those of reconciling the speeds of engine and dynamo in an economical and satisfactory manner, and not of efficiency in transmission, it does not properly have a place in this discussion.

The action of forces when power is transmitted by belts is shown in the diagram, Fig. 1, in which T represents the pull of the tight side of the belt, and L the tension in the loose side, when work is being done. It is evident that while the sum $(T + L)$ of these two forces exerts a pressure on the bearings of pulley A, only their difference or $T - L$ is available to do work, for it requires a portion of the force T, equal to L, to neutralize the tension in the loose side of the belt.

The conditions under which the Evans system operates are shown diagrammatically in Fig. 2. The line P represents the pressure on the bearings, and the line F, the tangential force which is active in doing work and which, it is obvious, corresponds with $T - L$. Moreover, the force P corresponds with $T + L$, and the fraction $\frac{F}{P}$ with the similar fraction $\frac{T - L}{T + L}$.

In order, therefore, that the two methods may be equally efficient as regards the pressure on the bearings, the values of those two fractions must be equal.

The maximum value of $\frac{F}{P}$ is determined by the greatest coefficient of friction between iron and leather, obtainable under the peculiar conditions found only in the Evans system.

In many of the large number of belt tests which have been made, the pressure on the bearings, due to the pull of the belt, was actually weighed, thus giving direct readings for values of $T + L$.

Corresponding values of $T - L$ were found by dividing the number of foot lbs. measured by a brake, transmitted per minute, by the speed of the belt in feet per minute. From values of $T + L$ and $T - L$ obtained in this manner, values of T and L are readily found by simple addition and subtraction. The relations of the forces T and L so found, vary between wide limits under different conditions; but from inspection of the tabulated results of a long series of such tests, it appears that the relations which they should bear to each other to give the most economical results, in any given case, are quite clearly defined. Without going into a more detailed discussion, it may be said that with pulleys of equal size, to obtain the best results, $\frac{T}{L}$ should be not far from 2.35. The coefficient of friction corresponding to this value may be deduced from the formula $\frac{T}{L} = e^{f\theta}$, in which e is the Naperian logarithm base, and θ the arc of contact on the smaller pulley.

The value of f found in this way when $\frac{T}{L} = 2.35$ and $\theta = 180°$, is 0.27. This coefficient is one from which the best of results would be predicted in the light of independent tests made to determine the coefficient of friction of leather belting on iron pulleys, under conditions as nearly as possible like those met with in practice.

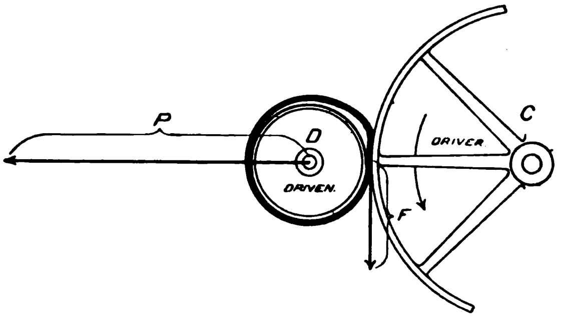


FIG. 2.

In dynomo work, the contact of the belt on the smaller pulley frequently does not exceed 150°. In such cases the value of the fraction $\frac{T}{L}$, corresponding to $f = 0.27$, becomes 2.03.

Values of $\frac{T - L}{T + L}$ derived from values of $\frac{T}{L} = 2.35$, and $\frac{T}{L} = 2.03$, are $\frac{T - L}{T + L} = 0.40$, and $\frac{T - L}{T + L} = 0.34$, for the pulleys of equal diameters, and for those of unequal size, respectively.

If, then, the coefficient of friction between iron and leather, as used in the Evans system, is as great as 0.40 and the assumptions made in regard to the open belting are correct; as much power can be transmitted with no more pressure on the bearings than with ordinary belting, working under the most favorable conditions, with pulleys of equal size; and the same would hold true in comparison with the unequal-sized pulleys similarly used, if the coefficient of friction should be 0.34.

Just how great this coefficient may be, and to what extent it is, influenced by the peculiarities of the Evans system could be easily determined by experiments similar to those made to determine constants for open belting.

Values of $\frac{T-L}{T+L}$ as low as 0.20 and as high as 0.78 have been recorded. In order to obtain the smaller value, however, it was necessary to employ a very great pressure (85 pounds with a belt speed of 4,500 feet) per horse-power; or, in other words, this value was obtained by using an unnecessarily large belt, which was strained unnecessarily tight. The value of f in this case was 0.13.

On the other hand, to obtain the 0.78 value, a value of f as great as 0.66 was required, although the pressure on the bearings per horse-power with a belt speed of 4,500 feet was only 10 pounds. An excessive amount of slip, however, was required to maintain these conditions; a slip so great, in fact, that it was with difficulty that the belt could be kept on the pulleys. In other words, the belt had either to be so much overworked, or else run so slack, that there was an impracticable amount of slip. The values selected for $\frac{T-L}{T+L}$ (0.40 and 0.34) as of the best to use, correspond to a coefficent of friction of 0.27, a slip of about 6 feet per minute, and a pressure on the bearings of about 18 and 21 pounds per horse power for the equal and unequal sized pulleys respectively.

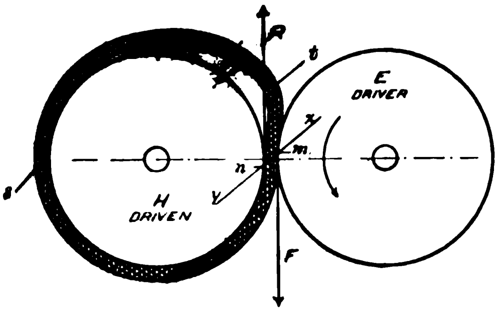


Fig. 3.

These comparisons do not have to do with the width of belt necessary to do equal amounts of work in each case. This might be determined in the case of the open belt, by dividing the tension in the tight side of the belt by the greatest allowable strain per unit width, and in the other case by dividing the total tangential force required to transmit the given power, by the greatest tangential force per unit width which can be safely employed.

The width of belt required in the latter case will be greater than in the former, but it does not follow from this that the pressure in the bearings must be greater. Within the safe working limits of the friction, the pressure on the bearings is probably independent of the width of belts used.

The peculiarities of the Evans system, to which reference has been made, are manifested by the shape into which the friction belts are distorted, as shown in Fig. 3. In order that there may be uniform motion the driving force, F must of course be balanced by a nearly equal force R, and while the force F is applied on the outer side of the belts, the resisting force R is exerted on the inner side, thus forming a couple, of which the thickness of the belt is the moment arm. The rotative effect of this couple distorts the belts into the shape shown, and the loose part of the belt will not be found in practice at s as might be expected, but at t, if the conditions are as shown in the diagram.

In consequence of this *trip*, the centre of pressure of the driving pulley E on the belt, will be transferred to a point m, above the line of centres (in the case shown) and to a point n below the line of centres on the driven pulley H, and the pressure will be transmitted through the belt in an oblique direction $x\,y$. Owing to this feature, moreover, the area of contact on both pulleys is of course increased, and the contact surfaces distributed in a decidedly advantageous way. It is probable, too, that a higher coefficient of friction is obtained on account of the more perfect contact arising from the comparatively great pressure per square inch, than would be obtained if the belt were used in the ordinary way.

Another interesting fact in this connection is that, since the pressure is partly due to the effect of the couple, and since the moment of the couple is proportional to the load, the pressure on the bearings is also to a certain extent proportional to the load. This is very prettily demonstrated in practice in that it has been found that a pressure on the belts so slight that they could be slipped between the pulleys when at rest, is sufficient, when supplemented by the "trip" of the belts, to carry the full load. In ordinary belting, the sum of the tension in each side of the belt ($T+L$) is known to be nearly constant, whether at work or at rest.

Comparative results so far obtained in practice, agree well with the theoretical comparisons which have been made. It has been found that under perfect conditions a tangential force of 28 or 30 pounds per inch of width can be sustained by the friction belts without overloading, and without undue pressure, but, as perfect conditions are rarely obtainable, that 20 or 22 pounds is the safest and best constant to use.

It is of course essential to the successful working of this friction, to have pulleys which are both firm and true, and to have their faces parallel *when under pressure.*

It would ordinarily be impracticable to employ a very wide face on an overhung dynamo pulley on account of the difficulty which would be found in keeping the outer edge up to its work, and for this reason it would be desirable to use an outboard bearing, or a "double drive" on dynamos consuming more than forty or fifty horse power. By such special arrangements much larger powers can be handled to good advantage; the objection to them, if it is an objection, being the necessity of having a special armature shaft, and, in the case of the double drive, of the commutator not being quite so accessible from all sides. The mechanical advantages which would be gained, however, would in most cases outweigh the objections.

THE ELECTRIC LIGHTING OF TRAINS.

Professor Kohlrausch has reported on the experiments which have been made in the electric lighting of railway trains between Cannstadt and Stuttgart, and his conclusions are that such lighting must be independent of the locomotive, and that it must be on the accumulator system. He disapproves of carrying a dynamo, owing to the consequent increase in the number of couplings in the train, and advocates charging the accumulators by means of fixed engines at various stations, and changing the batteries when approaching exhaustion. This system is stated to have been successfully carried on by the Oerlikon Company on Swiss railways.

A USEFUL APPLICATION OF THE CHLOROCHROMIC ACID BATTERY.

An interesting application of the chlorochromic acid ($CrCl_2O_2$) battery to portable incandescent lamp lighting was made last autumn in France by the underground explorers, MM. A. Martel and G. Gaupillat, who employed a battery of the Renard type (zinc platinized-silver) containing six cells, and capable of supplying current during five hours to a 12 or 15 candle-power lamp. Candles and magnesium lights were out of the question, owing to the exhalations from the stagnant subterranean waters. The whole apparatus was 12in. high, 8½in. in diameter, and weighed 17½lbs., which was not excessive for the purpose, since the lamp was carried on a small boat. The composition of the solution was approximately as follows: Chromic acid, 1½lb.; hydrochloric acid, 1 pint; sulphuric acid, ½ pint; water, 3 pints.

A SIMPLE ELECTRICAL SAW.

In a recent issue of the *Chemical News*, Mr. H. N. Warren says, whenever a powerful electrical circuit is closed by a platinum wire of suitable dimensions, the well-known heating effect of the same is at once manifested; yet no one seems to have been struck with the idea that the simple heated wire may be employed as a most effective disintegrator of the hardest organic compounds. A similar but more convenient article may be constructed as follows:—It consists of two upright pieces of very stout brass or copper wire, connected at the lower extremities by a nonconducting medium, while across the top is secured a piece of moderately thin platinum wire. On thus connecting the apparatus by means of side binding screws to the terminals of about four Bunsen batteries, the platinum wire at once becomes heated to bright redness, and will be found to cleave the hardest wood with great facility, insomuch that a large number of useful appliances may be thus manufactured in a short space of time. Owing, however, to the platinum wire frequently breaking, probably on account of its intimate contact with the carbon whilst at an elevated temperature, the author has devised and used with advantage a modified wire, formed by depositing metallic platinum upon fine steel wire, by exposing that substance to the action of the electric current in contact with an ethereal solution of platinic chloride.

DO THE LINES OF FORCE ROTATE WITH THE MAGNET?

Although many eminent men of science have vexed themselves over the question whether the lines of force caused by a magnet do, or do not, rotate with it as it revolves, no one, as far as we are aware, has suggested a crucial experiment capable of deciding the matter. This task has been attempted by Mr. Tolver Preston, who, in the February number of the *Philosophical Magazine*, proposes to rotate a cylindrical magnet near a metal disc placed perpendicular to the axis of revolution. If the lines rotate with the magnet the disc will become charged to a higher potential at the edges than at the centre, owing to its behavior as a disc dynamo. If, however, the field remains fixed while the magnet revolves, the poles will become charged to a higher potential than the middle portion, owing to the tendency to induce currents through the magnet itself. This polar charge will act by ordinary static induction on the disc, the two faces of which will exhibit electricities of opposite kind. Tests made with a delicate electrometer of the electrical state of the disc should therefore decide between the two hypotheses. Unfortunately the experiment can only be made by those who have very delicate apparatus at command, as it appears that otherwise very high velocities of revolution are necessary to produce the effects predicted.

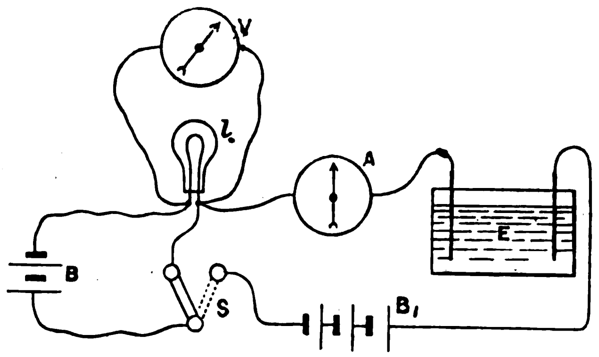
INSULATING HORSES.[1]

A writer describing a terrible storm at the Cape of Good Hope which came upon the cavalry known as the "Diamond Field Horse," killing ten men and five horses, advises that cavalry men and their horses in tropical countries be insulated,—in other words, that the bits and accoutrements be covered with rubber, that the swords of the men have rubber scabbards, that their sword guards be covered with hard rubber, and that all of the metallic portions of their accoutrements that are more for ornament than for use, be rubber trimmed. Aside from this, we would add that a rubber bit is one of the most comfortable things ever put in a horse's mouth, and if he were shod with rubber shoes—as many of them are—his feet would last very much better, he would be able to travel more miles a day, and while it might not keep him from the lightning stroke, it would certainly add to his comfort and efficiency.

TESTING PRIMARY BATTERIES.[2]

BY I. PROBERT.

Having several times had occasion to make tests of new forms of small primary batteries which were especially designed to work direct small incandescent lamps, I found it impossible to determine the exact amount of current flowing by the direct use of an ammeter, as the resistance of the latter, although low, was still sufficiently great to materially reduce the current when the ammeter was inserted in the circuit. The arrangement shown in the figure, I found, got over the difficulty entirely, and, as it may prove equally interesting to others, I am induced to publish it.



Method of Testing Primary Batteries.

The battery B, to be tested, is joined up to the lamp, l (which has a voltmeter, V, across its terminals), the switch, S, being turned to the position shown. Under these conditions the battery works direct on to the lamp which glows at its full brilliancy, and the voltmeter, V, gives the voltage between the lamp terminals. In order to determine the current, the switch, S, is turned to the position shown by the dotted lines; this brings into circuit the auxiliary battery (I have used, preferably, small portable accumulators for this purpose, as they have a low resistance), the ammeter, A, and the electrolytic cell, E. The current from B, although reduced by the resistance of the ammeter, is reinforced by the auxiliary battery, B^1, and by adjusting the distance between the plates of the electrolytic cell the current can be adjusted to the greatest nicety, until the deflection on V is the same as it was previous to the turning of the switch, S; hence the ammeter, A, now shows the current which under the latter conditions was flowing through B. The observation being taken on A, the switch, S, is turned back to the position shown in the figure, and the battery, B, continues to work under the practical conditions.

It should be added that by this arrangement not only can the true energy expended in the lamp be obtained for the stated candle-power, but by removing the lamp from the battery, and adapting it to a movable bridge astride a mercury trough, the light can be easily measured without interposing unnecessary resistance between the battery and its lamp.

CONSUMPTION OF RAW MATERIAL.

During the past year the Thomson-Houston Co. consumed nearly 2,500,000 pounds of copper wire, and about 450,000 pounds of brass rods, castings, etc.

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[1] *India Rubber World.*

[2] London *Electrical Review.*

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XI. NEW YORK, MARCH 25, 1891. No. 151.

> *We bring our doubts and differences to the bar of nature, and the verdict is convincing to all. It is truth, which is the soul of science.*—*Alfred M. Mayer.*

ELECTRIC TRAIN LIGHTING.

THE number of railroad cars in this country which have thus far been equipped with the electric light exceeds greatly that of any other country, but up to the present time very few, if any, statistics have been published which would enable the engineer to determine the exact economy of this mode of illumination as compared with others, heretofore in vogue. We have been told, in a general way, that the electric method of illumination is much more expensive than that by gas or oil, but the exact ratio has been left to conjecture, and has probably led to erroneous conclusions among those engaged in the departments in which this work falls. Considerable interest therefore attaches to a paper on Car Lighting, recently read before the Western Railway Club at Chicago, by Mr. George Gibbs, mechanical engineer of the Chicago, Milwaukee & St. Paul Railway. This gentleman, whom we know to be a thoroughly competent engineer, has gone very exhaustively into this subject and the results obtained by him are well worthy of study. In his paper he classifies the methods of lighting under eight headings, namely: 1, candles; 2, vegetable oils; 3, mineral or petroleum oils; 4, ordinary coal gas; 5, carburetted coal gas; 6, rich or oil gas; 7, carburetted air; 8, electric. It is the last, of course, which interests us particularly, and in treating of this Mr. Gibbs at once dismisses primary batteries from consideration, as being, on the face, too expensive for practical application for this purpose. Regarding secondary batteries employed alone, this method is also claimed by Mr. Gibbs to have shown itself incapable of extended application, although it is now said to be in use on the Canadian Pacific to a limited extent, on the Burlington, Cedar Rapids & Northern, and on some parlor cars on the Pennsylvania Railroad. The lighting of trains by a dynamo driven from the car axle is also pointed out to be attended with mechanical difficulties on account of the nature of the bogie trucks employed in this country.

Mr. Gibbs began experiments on the St. Paul road about two years ago and first employed an arrangement involving a dynamo and storage batteries. His experience went to prove that this method was too expensive, its most serious defect being the large first cost, rapid depreciation of batteries and multiplicity of details requiring skilled attention, as well as the poor economy of the special engine and the wasteful character of the whole arrangement in current. After one year's experience with this arrangement Mr. Gibbs came to the conclusion that greater economy could be obtained by relying upon direct generation of the current by a dynamo run by a special steam engine, and this is the plan which has been in operation ever since, and upon which his calculations are based.

Probably most interest attaches to Mr. Gibbs' calculation of the cost of the various systems of lighting, and this is shown in the accompanying table:

	Candle power per car.	Running cost per car per hour, cents.	Cost per c. p. per hour, cents.	Cost of equipment per c. p., cents.
Mineral Oil.....	168	2.51	.015	0.67
Pintsch Gas....	170	2.60	.015	3.24
Frost Gas......	180	4.60	.026	2.98
Electricity......	160	9.83	.061	2.47

Here, it will be noted, the cost of equipment per candle power by electricity is less than that of gas by either system enumerated, although considerably higher, as might be expected, than by mineral oil. On the other hand, it is shown that the running cost per car per hour by electricity exceeds that of oil and gas. While the results obtained by Mr. Gibbs may be true as far as they go, we think that a more extended experience with the electric system and the equipment of a larger number of cars will tend to reduce the discrepancy in cost which is now shown to exist. The item for attendance, with electricity, is absurdly large in the figures given. Of the many hundred cars on the road only 64 have thus far been equipped with the electric service, aggregating only 1,128 lamps, so that the basis of comparison is made on but a very small "retail" equipment as compared with the other "wholesale" methods of illumination. As regards the electric system generally, Mr. Gibbs considers it adapted in the present state of the art to special service only. He acknowledges that it fills, in a perfect manner, the requirements for a railroad light, and that in many instances it will undoubtedly pay for itself many times over, and that its cost is at present its only draw-back.

It may not be out of place here to note the fact that Mr. Gibbs points out that many of the requirements of a satisfactory car light system appear to be embodied in the present oil system, or might be, with some improvements which are readily obtainable. Of course this is also to be taken as coming from the "railroad standpoint," but we doubt whether the traveling public will coincide with Mr. Gibbs' views on this point, and are strongly inclined to the opinion that railroad companies will, in spite of the increased cost of electric lighting, find it to their advantage to employ it, as Mr. Gibbs suggests. On the other hand, we believe that tests made on other roads show decidedly greater economy than obtained by Mr. Gibbs and we may soon have occasion to recur to this subject.

STORAGE BATTERY TRACTION.

There are perhaps few practical applications of electric power about which there is a greater lack of knowledge than the true state of storage battery traction, and the conditions which must be fulfilled in order to obtain success. It may be stated broadly that, with the storage battery as we find it even to-day, success can be attained where the conditions do not subject the battery to such heavy duty as to cause its early disintegration, and where the number of cars operated is sufficiently large to keep the fixed charges per car within a proper limit. The recent stoppage of the Lehigh Avenue road in Philadelphia, which had been in operation for nearly a year, has again raised the question of the adaptability of storage batteries to this class of work. But we believe that, taken in connection with the character of this road, which involves heavy grades and curves, the small number of cars in operation, and, above all, the very light and intermittent traffic, the results obtained were no more than could have been expected. The electrical figures show the steady improvement that was going on all the time, and in fact it may be said that it was only a question of time when, even in this instance, results would have turned out more favorably than they did. This remark refers more particularly to the financial question, which, it is true, was the determining factor in the withdrawal of the electric cars. From the operating standpoint, the results obtained were of the most encouraging character, and they also substantiate well the claims made for the worm-gearing employed on these cars. With the advent of a storage battery which will permit the heaviest draughts upon it without deterioration, the storage battery will, we are sure, find a field not only on roads of easy grades, but for those, even, with considerable gradients.

DETERMINING THE QUALITY OF IRON.

Much has been said and written on the law of the electromagnet and its application to the construction of dynamo electric machinery. But, however valuable this data may be from the standpoint of a working theory, all such calculations are based on the assumption that the iron employed has a given permeability or magnetic conductivity. If all irons, even of the same class, possessed uniform qualities, the results of calculations might be applied directly, and give results varying but little from those indicated by calculation. Unfortunately, however, the quality of iron is subject to such large variations that the results obtained in actual practice frequently depart very largely from those of calculation; and when the results, obtained without a proper test of the iron, come out within a reasonable percentage of the pre-determined quantity, it is probably due to a lucky combination of circumstances, in which one error balances another. But with the present state of our knowledge there is no reason why the designer of dynamo electric machinery shall go astray for want of a proper method of determining beforehand the quality of the iron with which he is dealing. It has recently been suggested that much might be gained by the issuance of standard pieces of iron, much in the same way as standards of electric resistances are now issued. While such standard iron bars would, without doubt, be of considerable value, a simple instrument which enables one to determine exactly and expeditiously the magnetic quality of a sample of iron must be still more far-reaching and ought to find a place in every establishment in which dynamo electric machinery is built. The differential magnetometer of Mr. Rudolph Eickemeyer, which is so clearly described by Mr. Steinmetz on another page, will be recognized at once as an instrument which, if intelligently applied, removes instantly the one great factor of uncertainty in the design of dynamo electric machines. By casting a test bar with each field magnet and subjecting it to magnetic tests on the magnetometer, a complete knowledge of each individual piece of magnetic material involved in the construction of machines is obtained. The results already obtained with this apparatus by Mr. Eickemeyer leave no doubt that when once its benefits are thoroughly appreciated the magnetometer will form a prominent adjunct to every electrical laboratory.

TELEPHONIC DISTURBANCES.

Telephony plays such an important part in our daily life that investigations into the nature of the disturbances which are experienced in this work are of the highest importance. The great bugbear of telephony, induction, ascribed, and naturally so, to electro-dynamic interaction between parallel conductors, seemed to indicate that freedom from telephonic disturbance could be obtained by the employment of metallic conductors. More recent researches, however, have shown that other causes must be taken into consideration in the attempt to secure silence in telephonic conductors. Among those who have given this question their consideration, Mr. J. J. Carty deserves special mention on account of the light which he has thrown upon the relatively greater effect which electro-static induction has upon neighboring telephone conductors as compared with that due to dynamic induction. Mr. Carty's paper, read before the Institute, will be found full of suggestions in this field, and the results appear certainly to justify his closing remark that the time may come when we shall return to single telephone circuits in preference to "metallic."

A Trolley Road for New York City.

After a careful hearing of all the statements and evidence on the subject, the New York State Railway Commission has flatly decided in favor of the trolley system for the "Huckleberry" road in the northern suburbs of the city; thus agreeing with the opinion already expressed by the Board of Electrical Control. The Commission says that the electric road will of great benefit to the district through which it passes.

INDUCTIVE DISTURBANCES IN TELEPHONE CIRCUITS.[1]

BY J. J. CARTY.

It was not known until 1838 that the earth might be used instead of a return wire in the circuit of a telegraph line. This fact was discovered by Steinheil, while making experiments to determine whether the track of a railroad could be used to complete the circuit instead of a return wire. Steinheil's discovery has been considered as one of the most important in the art of telegraphy, and since his time it has been the almost universal practice to use the earth as a return in telegraph circuits. When, however, the earth return is used with the telephone, it is found that owing to the extreme sensitiveness of that instrument, many foreign currents, which would produce but little effect on telegraph instruments, become a source of serious trouble. For this reason, in telephony it is often necessary to use a complete metallic circuit. Thus it has come to pass that a return to the original practice of employing metallic circuits, as in the case of the crudest telegraph instruments, is now regarded as a most important improvement in connection with that most highly developed of telegraph instruments, the telephone.

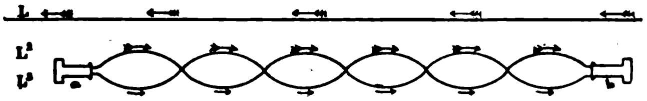

FIG. 1.

To obtain complete freedom from inductive disturbances in the telephone, it is necessary not only to use a metallic circuit, but to place the two wires composing the circuit in a special relation to the source of disturbance. One of the methods of so arranging the wires is shown in Fig. 1.

In this case the two sides of the circuit L^2 and L^3 are twisted spirally about each other, so that their average distance from the disturbing wire L^1 shall be the same. With such a plan, the telephones *a* and *b* are not affected by induction from the wire L^1. This fact has usually been explained by assuming that a current, commencing to flow in L^1, tends to induce two currents in the opposite direction to itself, one in the wire L^2 and the other in the wire L^3; that both currents are of the same strength because the average distance of L^2 and L^3 from the disturbing wire L^1 is the same; and that the telephones *a* and *b* are silent because they are acted upon by two equal and opposite forces. The above theory seems at first sight to be correct, and indicates the line of explanation adopted in many works treating of the subject.[2]

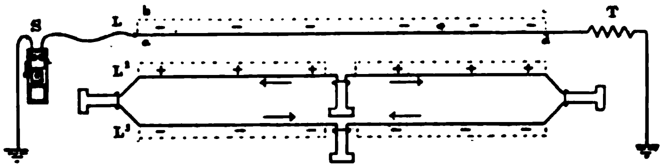

FIG. 2.

I have made a number of experiments which seem to prove that in the case described, the inductive action, instead of tending to produce a simple current in each side of the metallic circuit, actually does produce a number of different currents in each wire and in both directions.

In Fig. 2, L^2 and L^3 are two well insulated copper wires, 500 feet long and three feet apart. These wires are joined together at each end through an ordinary telephone. L^1 is a well insulated wire similar to the other two and placed within one-half an inch of L^2. At one end of L^1 is placed a Blake transmitter T and at the other end is placed a subscriber's bell S; L^1 being grounded at both ends as shown. When the transmitter T is operated, either by speaking into it or by vibrating a powerful tuning fork in front of it, disturbances are produced at the end telephones.

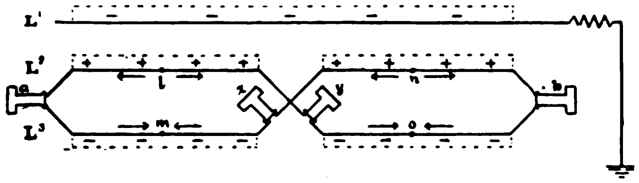

FIG. 3.

If telephones are inserted at the centre of L^2 and L^3 it is found that at those points no sound is heard, while the noise of the end telephones continues as before. This constitutes a simple case of inductive disturbance, and can only be explained by assuming that the wire L^1 acts electrostatically upon the circuit composed of L^2 and L^3, or in other words, that we are dealing with a system of condensers in series, of which L^1 constitutes one plate, the earth another and the wires L^2 and L^3, two intermediate plates which are joined together through the end telephones.

Let us assume that at a given instant, the height of potential along the wire L^1 is represented by the lines *a b* and *c d*, and the charge upon L^1 by the rectangle *a b c d*. The presence of this charge, which we will say is of the minus sign, is accompanied by an equal but plus charge on L^2. This produces a minus charge on the wire L^3, which in turn acts upon the earth. Now we will assume that the potential on L^1 is reduced to zero. This causes a restoration of the equilibrium in the circuit composed of L^2 and L^3, which is accompanied by a set of currents as represented by the arrows. The plus charge on L^2, flowing through the end telephones, neutralizes the minus charge on L^3, thus leaving a neutral point at the centre of each of the wires L^2 and L^3.

In this and the succeeding experiments the induced charges are represented by rectangles. This is not a strictly accurate method, but as an error in this respect only affects the result quantitatively, and cannot alter the conclusions, I have adopted it on account of the simplicity of treatment which its permits.

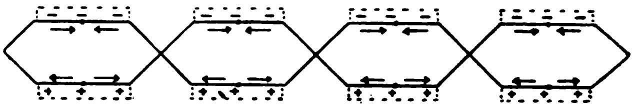

FIG. 4.

The potential along the wire L^1 at a given instant is represented as being constant, as it is found that owing to the high impedance in the instrument S, there is practically no fall of potential in the wire itself. Furthermore, it was found in the experiments about to be described that the results were the same whether the disturbing wire was open or connected to earth through the bell S. There would be a fall of potential along the wire L^1 if it were of such a length as often found in practice, and the distribution of the charge would be modified accordingly. But as this fact would only affect the location of the neutral points, the question of the fall of potential will not be taken into consideration, and the disturbing wire will be shown open at one end.

Fig. 3 shows the same circuits as used in the previous experiment, except that the wires L^2 and L^3 are caused to change places at their centres but are continued in the same plane, as in Fig. 2. This is what is called a "transposition." The telephones at the ends and in the middle are retained as before. Under these conditions, when the transmitter is operated, a diminished sound is heard at *a* and *b*; and *x* and *y*, instead of being silent as in the first case, now emit a sound of the same intensity as *a* and *b*. When telephones are placed at the quarters *l, m, n, o,* the sounds at *a b* and *x y* continue as before, but nothing is heard at *l, m, n, o*. The effect of this one transposition has been to reduce the disturbance at the end telephones *a* and *b*, and to cause a shifting of the neutral points from the centres to the quarters, and an increase of their number from two to four.

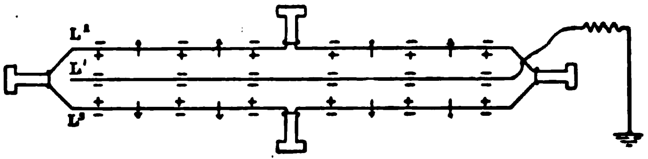

FIG. 5.

An examination of the induced charge shows how these results have been brought about. It will be seen by reference to Fig. 3, that there is on the first half of L^2 a positive charge, and on the second half a negative charge, and on the first half of L^3 a negative charge, and on the second half, a positive charge. When the positive charge on L^2 discharges, half of it goes through the telephone *a*, and half through the telephone *y*. The positive charge on L^3 escapes in a similar manner, half going through telephone *x*, and half through telephone *b*. This produces four currents, two starting from point *l* and two starting from the point *n*. One of the currents from *l* meets a current at *o*, coming from the point *n*, and one of the currents starting at the point *n* meets a current at *m*, which started from *l*. The currents flowing through the end telephones in this case are not so strong as when no transposition is employed, because they are due to an induced charge which is represented by an area half as great. It is found that as the number of transpositions is increased the number of neutral points is also increased, and that the area representing the charge, which escapes through the end telephones is reduced. To obtain silence, therefore, it is necessary to increase the frequency of transpositions until the discharge through the end telephones is so small as not to produce sounds therein. Fig. 4 shows a circuit containing three transpositions, one at the centre and one half way between the centre and each end. In this case, if we could neglect the resistance of the telephones, the current going through the ends would be reduced to one fourth of its original proportions, and eight neutral points would be produced, one in each wire at the centre of each transposition.

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[1] A paper read before the American Institute of Electrical Engineers, New York, March 17th, 1891.

[2] *A Handbook of Practical Telegraphy*, R. S. Culley, 1885, p. 330. *The Telephone*, Preece & Maier, 1889, p. 134. *Die Technik des Fernsprechwesens*, Dr. V. Wietlisbach, 1886, p. 135.

In practice the impedance of the telephones must be taken into consideration, so that if in Fig. 8, the middle telephones *x* and *y* were omitted, the neutral points would be found to move towards the ends, and the currents flowing through the end telephones would be correspondingly reduced.

According to this theory of transpositions, if the instruments and distances between wires on a given circuit remain constant, for a given period of alternations in the disturbing wire, the number of transpositions necessary to obtain silence will depend on the E. M. F. of the disturbing wire, and the specific inductive capacity of the dielectric. An increase in the value of either of these factors will, if silence is to be maintained, require additional transpositions, their number depending upon the value of the change which is made.

Where the disturbing wire is placed at an equal distance from both sides of a metallic circuit, no noise is produced in telephones located in that circuit, and a balance once being obtained, it is independent of both the E. M. F. of the disturbing wire and the specific inductive capacity of the dielectric. Fig. 5 shows such an arrangement of circuits—L^2 and L^3 are the two wires composing the metallic circuit placed the same distance apart as before, and the disturbing wire is at an equal distance from both. When the disturbing wire is in operation, no sound is heard at the end telephones, or at telephones located at the centres. This may be accounted for by assuming that at a given instant a negative charge is on the disturbing wire, which produces a positive charge on the inside of L^2 and L^3 and a negative charge on the outside of those wires; and that when the charge is removed from the disturbing wire, a set of currents is set up in the wires L^2 and L^3 in a direction at right angles to their axes, as shown by the arrows. In this case the flow is lateral, and no current passes through the end telephones or through telephones located at the centres. It will thus be seen that this method of arranging wires differs essentially in its action from the plan of using transpositions. Unfortunately, however, its practical application is limited to two circuits.

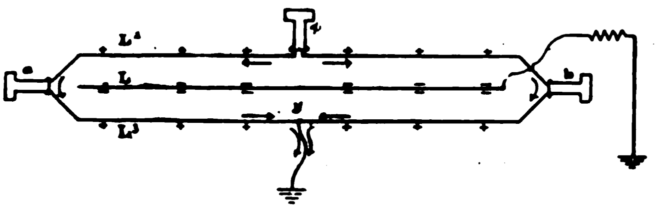


FIG. 6.

Where the disturbing wire occupies the position shown in Fig. 5, the flow in the conductors is lateral only when the wires L^2 and L^3 are insulated from the earth. If a ground be attached to the centre of L^3, as shown in Fig. 6, the flow of current becomes longitudinal, and the telephones *a* and *b* are found to be affected by loud disturbances, while the telephone *x*, at the centre of L^2, is found to be silent. This is because the disturbing wire, which we will say is negatively charged, induces a positive charge upon L^2 and L^3 and a negative charge upon the earth. The discharge in this case is effected by two currents starting from *x*, which thus becomes a neutral point, and passing through the end telephones to the ground as shown by the arrows. If the ground be removed from the point *y* toward the telephone *a*, the neutral point will be found to move toward telephone *b*, and if the ground be put at the centre of resistance of the telephone *a*, the neutral point will be found to be at the centre of the telephone *b*. This is well illustrated in Fig. 7, where *a* and *b* are telephones of special construction, admitting of the attachment of grounding keys K^1 and K^2 at their respective centres. In this instance, when the disturbing wire is in operation and both keys open, no sound is heard at any of the telephones, the flow of current being lateral. If the key K^1 be closed, sound is immediately heard at telephones *x* and *y* located at the centres of L^2 and L^3, but the telephones *a* and *b* are still silent. This is because the charge and discharge take place along the conductors L^2 and L^3 to and from the earth at K^1, thus passing through *x* and *y*, *a* being silent because the currents go through it differentially, and *b* is silent because it is located at a neutral point. To prove that current flows through telephone *a*, another telephone may be inserted in the ground branch at K^1, and it will be found to be loudly affected. If both keys K^1 and K^2 are closed, silence is again obtained in the four telephones *a*, *b*, *x*, *y*. In this case the charge and discharge from the wires L^2 and L^3 divide at the centre and flow back and forth at both ends, *x* and *y* being silent because they are at neutral points, and *a* and *b* are not affected by the currents which flow through them because of the differential action referred to.

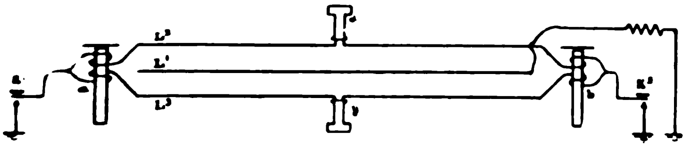


FIG. 7.

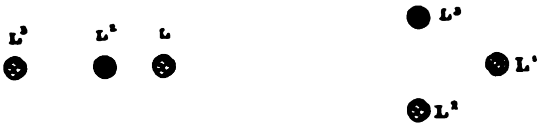


FIG. 8.

Two systems have been described, one in which the induced current is lateral, and the other in which it is longitudinal. I think it follows from the foregoing experiments, that where wires are twisted about each other as shown in Fig. 1, both of these actions are combined. At the left hand of Fig. 8, a cross-section of the three wires L^1, L^2 and L^3 [Fig. 1] is shown. In this position the wires occupy a place with reference to each other exactly as in Fig. 2, and the tendency of the disturbing wire is to cause a longitudinal flow in L^2 and L^3. If repeated cross-sections of these wires are made, a point will be reached at which the three wires are disposed as shown at the right hand of Fig. 8, where it is seen that the distributing wire L^1 is at an equal distance from L^2 and L^3, and the tendency is to produce a lateral flow. The actual currents produced must be the resultant of these two actions.

Fig. 9 shows a plan quite different in principle from anything heretofore employed. It is of interest not so much on account of any practical application which it may have at present, but because it is a very striking proof of the electrostatic nature of inductive cross-talk between telephone circuits. L^1, L^2 and L^3 are the same wires as used in the previous cases, L^1 being half an inch from L^2, with the addition of an extra wire L^4 placed half an inch from L^3 and joined by a conductor *w* with the disturbing wire L^1. L^2 and L^3 are three feet apart. When in this condition the transmitter is operated, no disturbance whatever is heard in the end telephones; if the wire *w* be disconnected, the usual noise is heard, but is found to disappear as often as L^1 and L^4 are joined together. This action is explained by the fact that L^4 is at the same potential as L^1, on account of being joined to it by the wire *w*, and acts with the same force on L^3 that L^1 does on L^2. The flow in this case is lateral, as indicated by the arrows; and the telephones are silent.

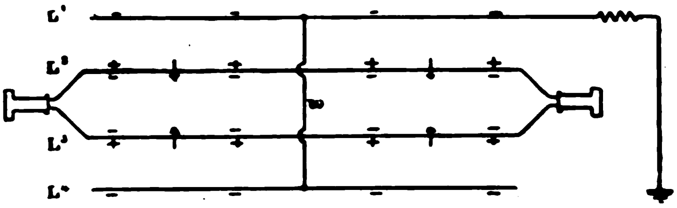


FIG. 9.

Neutral points may be produced in a circuit by the use of shunts. Fig. 10 shows the usual arrangement of circuits with the telephones *a* and *b* at the ends, and another telephone *x*, of equal impedance branched between the two wires at the centre. In this case four neutral points are found, two in each wire. The currents produced by the discharge are indicated by the arrows. Thus by the addition of one shunt, the disturbing currents in the end telephones have been reduced one-half. If similar shunts were placed at the quarters, the currents at the end telephones would be still further reduced to one-quarter of their original strength.

This plan is not a practicable one because of its shunting effect on the telephone current, but is of value as showing one of the actions which occur when instruments are bridged into metallic circuits. It is interesting to note that in Fig. 10 the telephone *x* is affected by a current twice as great as that which flows through either of the end telephones.

Before closing I shall describe one more experiment. In Fig. 11, L^1 is the disturbing wire and L^2 is a grounded telephone circuit placed one half an inch from L^1. At the centre of L^2 there is an ordinary telephone repeating coil or transformer C, containing two windings *e* and *f* of copper wire, each having a resistance of 160 ohms. One end of each winding is grounded, and the other end is connected to the line as shown. Assuming that the impedance of each telephone is equal to that of each coil of the transformer, a neutral point will be found at the centre of each half of L^2, and the disturbing currents flowing through the end telephones will be only half as strong as though the transformer were omitted. If now the connections of the transformer be reversed so that the discharges from the two sections of line pass through it in opposite directions, no magnetism will be produced in the core *k*, and consequently the transformer coils offer an easier path to the discharge. This causes the neutral points to move toward the end telephones and consequently reduces the disturbance still further.

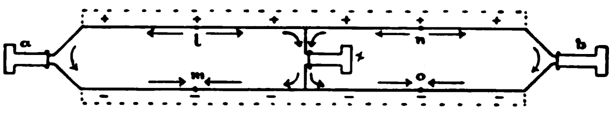


FIG. 10.

I have not had an opportunity of trying this experiment with a transformer whose coils contained a low copper resistance and a high inductance, but according to theory, we might expect that such a transformer having its coils connected differentially, should free a grounded line of considerable length from cross talk and other electrostatic disturbances. The number of such coils which can be worked in a given line is of course limited, but with properly designed apparatus a large number of them might be used. This arrangement is also interesting when considered with reference to electro-magnetic induction, and brings to mind a question as to whether we may not at some future time abandon the use of metallic circuits and again make use of Steinheil's discovery.

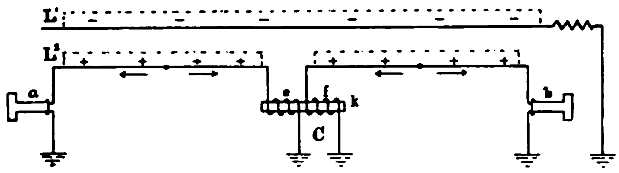


FIG. 11.

ON THE HEATING OF BRIGHT, FREELY SUSPENDED, COPPER WIRES BY THE CURRENT.[1]

BY U. BARBIERI.

IN order to calculate the rise of temperature of bright wires (suspended horizontally) by the current, there are various formulæ, those of Kittler, Uppenborn, Strecker, Sabine, &c. These formulæ give very different results, as the constants by which the ratio $\frac{c^2}{r^3}$ is multiplied in the formulæ vary between 0.1 (Sabine) and 0.03 (Strecker). The object of the present inquiry is to ascertain which of the existing formulæ express such rises of temperature with an accuracy sufficient for practical purposes, and, indeed, if any of them can be regarded as sufficient for all cases.

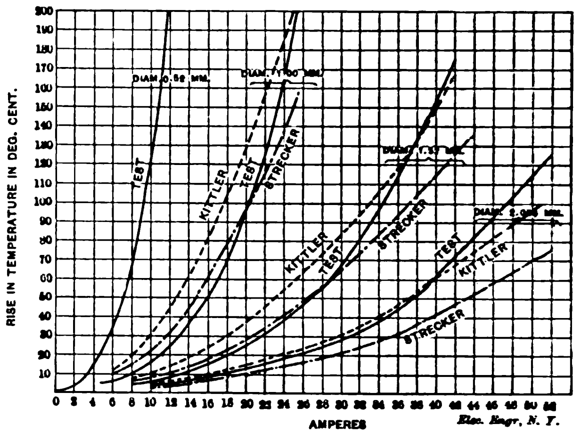
METHOD OF THE INVESTIGATION.

A wire about 7 metres in length is fixed securely at one end, and at the other it is carried over a pulley, the axle of which carries round with it synchronously a mirror. At the exact distance of 1½ metres from this rotating axle there is a scale, suspended vertically, which allows the values to be read off directly by means of a telescope.

At the end which passes over the pulley the wire is kept stretched by means of a weight equal to $\frac{1}{10}$th of the breaking strain as calculated from the section, etc. The temperature of the room is shown by three thermometers hanging near the wire.

Each wire was first overheated by a strong current in order that bends and other irregularities might be removed as far as possible. In the experiments the deflection of the mirror occasioned by the heating effect was observed. We calculated then from the radius of the pulley and the distance of the scale, the increase of length from which the rise of temperature is derived, by the aid of the coefficient of expansion of copper.

In order to be independent of the possible difference of materials as regards the coefficient of expansion, direct experiments on the thermic elongation of the description of copper used were instituted; rapid changes of temperature were effected by heating the room and then opening the windows (in winter).



RISE OF TEMPERATURE IN COPPER WIRES.

RESULTS.

Four copper wires (obtained from the firm Küstermann) of, respectively, 0.5, 1, 1.5 and 2mm. diameter were examined. The results are given in the accompanying table, and are represented by the curves. It appears from the numbers, that the so-called constant varies not only with the diameter, but that in one and the same wire it is not uniform with currents of different strengths.

Diameter of wire.	Strength of current.	Rise of temperature.	Constant.
0.52 mm.	3.2	10	0.0151
"	4.5	20	0.0154
"	6.2	40	0.0167
"	8.4	80	0.0176
"	9.8	120	0.0194
"	10 9	160	0.021
"	11.9	200	0.022
1 mm.	7.7	10	0.0206
"	10.7	20	0.0215
"	14.5	40	0.0228
"	18.6	80	0.027
"	21.3	120	0.033
"	23.5	160	0.036
"	25.7	200	0.0375
1.52 mm.	13.5	10	0.0234
"	18.3	20	0.0273
"	24.7	40	0.0275
"	32	80	0.0335
"	36.4	120	0.0371
"	39.5	150	0.0405
"	42	176	0.0420
2.004 mm.	14.5	5	0.024
"	19	10	0.027
"	25.2	20	0.031
"	33.7	40	0.036
"	39	60	0.039
"	43	80	0.043
"	47	100	0.046
"	51	120	0.047

If we take the mean values for the coefficient of the term $\frac{c^2}{r^3}$, their result, if we merely consider increases of temperature up to 100, we get the following numbers for the several diameters:—

Diameters.		Coefficients.
0.5 mm.	..	0.018
1.0 "	..	0.024
1.5 "	..	0.030
2.0 "	..	0.036

The formulæ of Kittler and Strecker are shown in the table of curves. We see that for thinner wires (1.0 and 1½) the former gives too high values between 0 and 100°; for a 2 mm. wire the theory agrees approximately with the experiments; it agrees closely with the increases of temperature which were observed in the 1 to 1½ mm. wires Both would probably show too slight rises of temperature, both for greater diameters and for higher strengths of current.

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[1] *Elektrot. Ztschr.*

Since the conclusion of this investigation comprehensive results on the question have been published by Kennelly. Still the foregoing communication will not appear superfluous, because another direct method was employed, which renders the results independent of a knowledge of the galvanic coefficient of temperature of the single wires.

Kennelly's figures refer to thicker wires, from 2 mm. upwards, whilst here thinner wires from ½ to 2 mm. have been considered, so that the two investigations are complementary to each other. The observations on wires of 2 mm. in thickness which have been carried out in both, allow a comparison of the results, which shows a satisfactory agreement as it appears from the subjoined conspectus:

RISE OF TEMPERATURE.	5° C.	10° C.	20° C.	40° C.	80° C.
STRENGTH OF CURRENT.					
Kennelly ..	12,	18,	25,	35,	47.
Barbieri ..	14.5,	19,	25.2,	33.7,	43.

THE ELECTRIC TRANSMISSION OF POWER.[1]

BY GISBERT KAPP.

THE lecturer commenced by explaining that before energy could be applied it must be transmitted, and that its transmission could be divided under two heads, the first being transmission over short distances measurable in feet or yards, and the second transmission over long distances measurable in thousands of feet or miles. The electric transmission of energy is generally used over long distances; the chief case in which it is employed over short distances is in the running of machine tools by means of electromotors which are supplied by dynamos fixed in the workshops.

The transmission of energy over long distances only was considered in the present lecture, and it was shown that it could be further divided into the two subdivisions of transmission of "live" energy by means of electrical conductors, wire rope, etc., and of transmission of "stored" energy by means of coal, corn, or falling water. The energy of falling water may be used to charge secondary batteries or to compress air, and the batteries or reservoirs of compressed air may be carried away, and the stored energy of the falling water may be transmitted to the place where it is required. It may easily be seen how corn may be carried from the field to a distance, and there used to feed horses, which will in return do useful work; or how coal may be taken from the pit's mouth to a distant city and there used to produce steam power. The value of any system for the transmission of stored energy depends upon the capital outlay and upon the working expenses, the latter in turn depending upon the storage efficiency, which is the ratio of the useful energy obtained at the end of the transmission, to the total energy absorbed by the system. The transmission of stored energy by the transport of secondary batteries was then compared with a similar transmission by means of compressed air, and the following results given:—

Total efficiency with batteries, 58 per cent.; weight of batteries, 100 lb. per horse-power hour.

Total efficiency with compressed air, 26 per cent.; weight of steel reservoirs and compressed air, 300 lb. per horse-power hour.

The transmission efficiencies of stored energy transmitted by means of coal, corn, or secondary batteries are given in Table III. Taking the case of the batteries and electromotor working on a tram line, it will be seen that if a car, itself propelled by the storage batteries it carries, is occupied in carrying charged batteries from the source of energy, say, a waterfall with generating machinery, to a distance, and taking them back when discharged, and the loss of energy in taking the batteries there and back is to be 10 per cent. of the energy originally stored in the battery, then the distance must be 10 miles there and 10 miles back, or 20 miles altogether. The distances given in the table are the theoretical distances, and are too great, as practically there would be considerable losses in inclines on the journey, and in starting and stopping; for these reasons the figures should be looked upon as merely approximations. From the table, it will be seen that the distance over which energy stored in coal can be transmitted with a given efficiency of transmission is enormously greater than the distance in the case of batteries. In the last column the coal transmission is no less than fifty times more efficient than the battery transmission. Besides the greater loss, the capital outlay for batteries is very large, and the depreciation 15 per cent. per annum. The figures in Table II., are based upon steam power at £10 per horse-power per annum, the steam power being used to generate the electricity for the batteries or direct mains. This table shows that for a transmission of 5 h. p., battery transmission costs more than "live" transmission by overhead conductors, but that it costs less than live transmission by underground conductors (except where the distance is about one mile or less). The cost of coal transmission for the distances mentioned in Table IV., would vary from £20 to £40 per annum per horse-power delivered. Where large steam engines are used at the end of large coal transmissions the cost per annum per horse power delivered will be about £10. Tables I., II., and VI., relate to the working of ordinary electrical passenger tramways where secondary batteries are used on each car and charged at particular charging stations.

The lecturer then went on to discuss the transmission of live energy from an electric light central station. In such a station the load due to the lighting varies greatly; during a few hours in the evening the station will probably be worked up to its full capacity, and then the production of electrical energy will be very economical, as all the capital outlay will be actively employed, and also the efficiency of the plant is greater when doing full work than when running light. During the early morning the load on a station may not be more than 10 per cent. of its full capacity, and during the daytime the output is very small; now, if, during these hours of minimum demand, the plant could be run at its full capacity, and the surplus energy distributed to electromotors, the working expenses would be only slightly increased, while the income of the station would be largely augmented.

In cases where motive power is required continuously, as, for example, in a small manufactory working 10 hours per day, or 3,000 hours per annum, it would not pay the manufacturer to use electrical power obtained from electric light mains, as compared with steam or gas power, unless it was supplied at 3d. or less per Board of Trade unit of 1,000 watt hours. Table VI. shows the connection between the cost per unit and the cost of a brake horse-power for 3,000 hours. To obtain his power from a small steam engine, the manufacturer would have to pay from £20 to £40 per brake horse-power for 3,000 hours, and the cost of the corresponding electrical energy supplied from electric light mains at 3d. per unit would be £33.5, as will be seen from the table. Now, the cost of a Board of Trade unit varies from about 4½d. to 12d., the average in London being from 7d. to 7¼d. But in many cases power is only required intermittently, and then electrical power is much more economical and convenient than steam or gas power.

TABLE I.

Storage Battery Tramcars.

	Birmingham.	Barking road.	Philadelphia.	
			Sm. car	Lge. car
Weight of car (in tons)	....	3.275	2.500	3.620
" motors and gear (in tons)	....	1.360	.980	1.140
" batteries (in tons)	2.850	2.400	1.770	2.450
" passengers (in tons)	3 300	3.600	2.230	3.600
Total rolling weight (in tons)	10 50	10.63	7.48	10.81
Percentage of paying load	31.5	34	30	33.3
Number of cells	96	96	84	116
Maximum current	....	70	70	80
Maximum energy at battery terminals (electrical horse-power)	....	19	14	23
Average energy at battery terminals (electrical horse-power)	....	6	4.8	5.4
Maximum energy per 10 tons of rolling weight (electrical horse-power)	...	17.8	18.7	21.3
Average energy per 10 tons of rolling weight (electrical horse-power)	....	5.65	6.42	4.95

TABLE II.

Transmission Plant for 5 H. P.

Distance of Transmission in miles.	Annual cost per horse-power delivered, if the transmission is—		
	By batteries.	Direct.	
		Overhead.	Underground.
	£	£	£
1	36.1	22.8	33.6
2	37.6	25.6	47.2
3	39.1	28.0	60.0
4	40.6	30.6	74.0
5	42.1	33.0	87.0

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1. Abstract of Cantor lecture delivered at the Society of Arts. (Tables 4 and 5 have been withdrawn.)

TABLE III.

Transmission of Stored Power.

Source of Power.	Distance in miles attainable with 90 per cent. efficiency of transmission over—		
	Road.	Tram.	Rail.
Coal and steam engine	115	270	1,300
Corn and horse.	52	170	410
Storage battery and electromotor..... ...	4	10	26

TABLE. VI.

Power Derived From a Central Station.

Cost of Board of Trade unit...........Pence	1	2	3	4	5	6	7	8
Cost of annual brake h. p. for 3,000 hours...£	12.9	23.3	33.5	43.9	54.2	64.5	75.0	85.4

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER *150 Broadway, New York city.*

THE STATISTICAL REPORT OF THE N. E. L. A.

There is an incident connected with the Providence meeting of the N. E. L. A. which should receive a great deal of attention, but which apparently has been already forgotten.

THE ELECTRICAL ENGINEER stated, or rather had the courage to suggest, that the meeting might have been made of more practical value to those engaged in producing electricity for light and power purposes. Why such a suggestion, and to what does it refer?

In looking over the papers that have been read before the Association, as well as those which have appeared in the electrical journals, one is very forcibly impressed by the fact that every subject relating to the business has received due consideration, with one very important exception; also, that while the opinion expressed by the electrical fraternity, differs somewhat upon many subjects, it is unanimous on one thing, that is, *that nothing shall be said relating to "power."* I shall assume that the suggestion made by the ENGINEER, included among other things *the question of power.*

Without power what would become of the capital and people now interested in, and depending upon, the great electrical industries? Does the *economical* production of power bear no relation to the *cost of operating a station*, or are all stations operated in the most economical manner? If such is the case, then there is a great difference of opinion as to what economy means; for proof we will refer to the partial report offered by the committee on data at the last meeting of the N. E. L. A.

Some have an idea that economy depends upon the amount of red paint in the station, and the quality of the office furniture; others that it is expressed by the statement that so many pounds of coal are required per horse power per hour. As a matter of fact, the simple statement of itself means nothing, and may, or may not, be an expression of economy, depending upon other necessary conditions.

However, we will first look under that part of the report. We notice that the *consumption of coal* per horse power varies from 2.1 to 12 pounds per hour, that a compound triple expansion engine uses 10 pounds of coal, while a throttling slide valve engine works along with 5 pounds.

The number of pounds of steam used per horse power per hour is very interesting, and we notice a slight difference, as expressed by 17 and 90 pounds. As a singular coincident the last is credited to "Waterloo."

The apparent evaporation of water per pound of coal, varies from 5 to 17 pounds. Five pounds, while small, bears the stamp of truth, which is entirely lacking in the latter case; moreover, it is impossible to evaporate any such amount of water with a pound of coal.

We find various means resorted to to remove scale from the boilers, and to prevent its formation; a few antiquated ideas in the shape of *bark* and *potatoes* are not overlooked. In some cases vegetable matter will remove scale; the same elements, however, have played a prominent part in assisting more than one boiler to vacate the premises in a most unexpected and disastrous manner.

The temperature of the feed-water varies from *cold* to 225°; it would be of interest to know how the high temperatures were obtained, for if we take the temperature of *cold water* as 45° and steam pressure at 90 *pounds* by *gauge*, we shall save about 9 per cent. of our coal by heating the feed-water to 225°.

The expense for carbons and labor for trimming an arc lamp is about the same in all cases. Yet with a few, a consumption of 1½ pound of *coal*, and even less, will produce 1 h. p. or run one full arc lamp for one hour; many, however, see nothing out of the way in using 10 or 12 pounds to accomplish the same result.

Cases are common where the cost of carbons and labor for trimming, as well as the price received for the light, are the same; but in one case ten (10) times the amount of coal is used as in another.

One mistake occurs under the head of *non-electric companies*, to which attention should be called. A 1,140 h. p. compound condensing engine is charged with a consumption of 30,000 pounds of coal in 10 hours; it should have been 30,000 pounds used in 24 hours, besides furnishing steam for heating purposes.

The committee on data are in a position to prepare the most valuable report ever presented to the electrical interests, and one which will do more toward increasing the dividends and business, as well as improving the service, than all the previous work of the Association in that line.

It is to be hoped that no worse cases than those noted will appear; at the same time it is a satisfaction to know that a few are doing far better than any named in the report.

E. P. SPARROW.

BOSTON, MASS.

THE NOISE IN THE ARC.

By an article published this week in THE ELECTRICAL ENGINEER under the head of "Tesla's Alternating Generators of High Frequency," the sound emitted from alternate current arc lamps is attributed to the contraction and expansion of the gaseous matter forming the arc. I am presuming this is a surmise on the part of Mr. Tesla. His experiments, which are very commendable and, without doubt, effective, might be unnecessary if some other cause of the noise were known. My opinion is that it is primarily caused by the fluctuations in the electrical pressure, rather than by the frequency of its alternations, and that the lamps may possibly have some accidental magnetic responding construction, which keept time with the impulses of the dynamo, perhaps in much the same way as Gray's analyzers do in his harmonic telegraph, in which ribbons of metal under different tension respond only to a certain given number of electric impulses in a given space of time through the aid of corresponding magnets all in the same circuit.

In this connection I will recount some experiments I made a number of years ago which have influenced this opinion. I was experimenting with a one-quarter horse power motor on a Brush direct current circuit of about 3,000 volts. The motor was wound in series and its armature had nine Pacinotti projections. I found by holding the pulley on the armature shaft that the motor gave out the same sound as the dynamo, *i. e.*, a loud humming noise without any apparent motion. This noise increased as the projections on the armature were allowed slowly to approach the field pole pieces, and decreased as they were withdrawn. The maximum noise in this experiment was quite as loud as that from half a dozen alternate current lamps in the same room. I then repeated the experiment with a motor of the same capacity which had a smooth core, but could get no sound.

It appears to me that Mr. Tesla approaches the desired result by decreasing the size of his magnetic projections and increasing their number, thus insuring a smoother current, rather than from the effects of higher frequency. If this is true, the solution should be in having an armature core without projections.

Mr. Tesla asserts that higher frequency of alternations decreases the danger of the current. This statement is misleading. It is the height of the induced waves, rather than their number or length, that plays the mischief. In an experience of over four years in the construction and operation of dynamos and motors for railroad work, I dealt with 300 volt machines having coarse projections on their armatures. I have since learned that it was quite as easy to insulate smooth core machines to carry 500 volts, and I would prefer to handle the terminals of the latter; besides, I am not now inclined to dodge my telephone friends, as was formerly the case. My dynamo armatures had but six projections on their core and the same number of spider arms. They were the first compound machines ever used in railroad work, and they kept the potential more constant than any I have ever seen, but they had a habit of wearing the commutator sections opposite the projections much faster than the other parts. We were completely relieved of this trouble by changing the number of projections and corresponding spider arms from 6 to 9.

In speaking of projections on armature cores, I am aware that it has become the fashion of late to use them more particularly on railway motors and I am tempted to ask the question, Of what use are they? If the work performed is proportional to the number of magnetic lines of force passed through by the armature wires, of what benefit is it to short circuit a portion of those lines of force through the core projections?

JNO. C. HENRY.

New York, March 20, 1891.

PRIORITY IN CONVERTER DESIGNING.

In a letter published in The Electrical Engineer of March 4, on pages 287 and 288, Mr. James Swinburne, referring to certain advertisements of the Westinghouse Electric and Manufacturing Company, uses the following language:

"There is no reason why they should have any monopoly of high efficiency in closed circuits, as any other maker can use good iron and follow the principles laid down in my British Association paper. I am quite aware, of course, that a scientifically designed closed circuit transformer can give 95 per cent. efficiency, but advocates of closed circuit transformers should do me the justice to admit that this high efficiency is not due to them. Until my paper was read at the British Associatian in 1888, little was thought of the loss in iron. I there showed how closed circuit transformers should be designed to give 95 per cent. efficiency; and since then makers have reconsidered the proportions of iron and copper in their transformers. As far as I know, nothing had been said before about proportioning the iron so as to get small loss by hysteresis. The high efficiency closed circuit transformers have been produced by following the lines indicated in my paper."

Disclaiming any desire to detract in the slightest degree from the credit justly due Mr. Swinburne for his always suggestive and often valuable work, I, nevertheless, esteem it a matter of simple justice to others to say that Mr. Swinburne is under a misapprehension concerning the influence of his British Association paper upon the practice of "advocates of closed circuit transformers," in so far, at least, as the Westinghouse Company is concerned. The first transformers put upon the market by this company were designed in 1886, and before the end of that year some of them were in the hands of local companies. Early in the following year, that is to say, not later than the summer of 1887, a line of transformers comprising five standard sizes was designed by the electrician of the Westinghouse Company, Mr. O. B. Shallenberger, and the first of these transformers were turned out of the shop in September of that year. The proportions of iron and copper were not widely different from those existing in the transformers first introduced into commercial use, but some slight modifications were made. From that time to the present the general dimensions of these transformers have not been changed except in the case of the 10-light transformer, and in that, the proportions of iron and copper have not been materially altered. Several successive and important improvements have been effected but these have not been accomplished by radically changing the amount of iron or the amount of copper, nor have they been effected by following the lines indicated in Mr. Swinburne's paper. On the contrary, the amount of iron is, in the latest transformers, relatively greater than in the first ones of this type.

Mr. Swinburne refers to his paper upon the subject of the relative amounts of iron and copper in transformers as having been read before the British Association in 1888. I do not remember that the journals of that date reported the reading of any such paper at that time. Is it possible that Mr. Swinburne means to refer to his very interesting paper which was read September 16, 1889, at the meeting of the British Association at Newcastle-on-Tyne?

Assuming, however, that the date given for the reading of the paper is not a mistake, it is, nevertheless, certain that the standard transformers of the Westinghouse Company have not since been materially modified with respect to the proportions of copper and iron, and that, while Mr. Swinburne may be correct in the statement that "the high efficiency closed circuit transformers have been produced by following the lines indicated in my (his) paper,' those lines of practice were sufficiently understood by others before Mr. Swinburne was heard upon this subject.

L. B. STILLWELL.

Pittsburgh, Pa., Mar. 19, 1891.

The Central Thomson-Houston Company report business as very brisk in all departments. They have just closed several large deals for arc and incandescent plants, stationary motors and several extensive street railway contracts. Their isolated business is also very active and increasing all the time.

European Correspondence.

LONDON.

Anglo-German Cables.—National Telephone Co.—Mutual Telephone Co.—Granville's Electric Log.—Anglo-French Cable.—Telegraph Construction Co.—Vienna Electric Railway.

The disturbances of the system of telegraphic communications between England and Germany, which occur even in comparatively fair weather, are now to be remedied. At present only two cables exist between Emden and Lowestoft, but the governments of the two countries, urged by repeated complaints, have agreed to lay a third cable. Each government is to bear half the cost, which will amount in all to about £120,000. A bill on the subject will soon be laid before the Reichstag and the operations for laying the cable will commence immediately upon the money being granted.

The directors of the National Telephone Company, Limited, announced last week the issue of £350,000 four and one-half per cent. debenture stock, forming part of a total amount of new debenture stock which is limited to one-half of the subscribed share capital of the company for the time being, and redeemable at the option of the company on six months' notice at £110. The capital of the company is now £4,000,000, of which £2,494,920 has been issued. Notice has been given to pay off the existing debenture stock and bonds. The new debenture stock will then be constituted a first charge on the entire undertaking and property of the company.

The first Exchange of the Mutual Telephone Company was opened in Manchester, on Saturday morning last, when sixty-five subscribers were put in communication. It was originally intended to begin with a much larger number, but the dense fogs of the last fortnight by impeding overhead operations, rendered it impossible to connect a larger number. Wires are however ready for fresh subscribers who will be added day by day until the full complement is supplied. I have previously mentioned that the object of the Mutual Telephone Company is to provide exchange communication of an improved character and at rates not exceeding £5.10s. a year. On account of the Edison patent, transmitters of the magneto type made by Siemens & Co., of Berlin, are used, but will be replaced by carbon ones in July, when the patents expire.

Granville's electric log, made by Messrs. Elliott, of London, is said to obviate many of the difficulties which exist in a ship's recording apparatus. Essentially an electric log, it however has no battery whatever, the log, the iron hull of the ship and the ocean together forming the battery. A portion of the log is made of zinc, which provides one element, while the iron plates of the ship form the other, the sea water constituting the exciting solution. The log is of very simple construction and has only two moving parts, a revolving head and a small internal worm wheel. The head is connected with the worm wheel gearing, and every sixth revolution of the former is communicated by means of a spring contact, through the tow line to an indicator placed on the bridge or in the chart house of the ship. When the log is in use the sea water has free access to all the working parts, and serves to keep them clean and lubricated. The tow-line which is very pliable, is made of a braided tanned netting twine, inside which a number of copper wires are wound spirally and joined together at each end. This line can be handled and coiled by a sailor in the same way as any other line, and is readily connected with, or disconnected from the log. The indicator consists of a small metal circular box with the necessary internal mechanism and external dials and pointers. The apparatus, after many months' trial at all speeds, has shown itself to be an efficient means of accurately indicating, at any part of the ship where an indicator is fixed, the total distance run, and also, at any time, the rate of speed per hour. One of these logs has been fixed on board the Orontes, and it is also in use in the Argentine Navy.

The submersion of the Anglo-French telephone cable will take place to-morrow (Thursday), and it is intended to proceed on Monday with the practical experiments, and if these are successful the cable will be opened on the 15th of this month. No privileges are to be granted to private subscribers or to newspapers. In Paris, subscribers will be permitted to correspond from their houses directly with London, but in London, communication will be made from the public telephone offices.

The Telegraph Construction and Maintenance Company, Limited, which held an annual meeting yesterday, is in a most flourishing condition. After paying 20 per cent., over £65,000 has been carried to reserve fund. Over 9,000 miles of telegraph wire has been insulated, and 4,000 miles of wires laid.

The Hungarian Minister of Commerce has rejected the petition for the concession of the electric railway between Vienna and Budapest.

H. S.

London, March 4, 1891.

Society and Club Notes.

FRANKLIN ELECTRICAL SOCIETY.

The meetings of this society, S. Cohen, corresponding secretary, will hereafter be held on the second and fourth Saturdays of the month, at 8 P. M. The next meeting will be held Saturday, March 28, at 8 P. M., at the rooms, 239-241 East 57th street, when an elementary paper on "Electric Traction" will be read by Mr. L. Newman. Visitors are invited to attend.

NOMINATIONS AT THE NEW YORK ELECTRIC CLUB.

At the annual nominating meeting of the Club, held at the Club House, Tuesday evening, March 17, officers for the ensuing year were nominated as follows:—*President*, O. E. Madden; *vice-presidents*, Samuel Insull, Chas. W. Price, Erastus Wiman and W. D. Sargent; *secretary*, Frank Z. Maguire; *treasurer*, Geo. B. Coggeshall; *board of managers*, H. L. Shippey, Dr. J. B. DeLery, P. H. Alexander, H. D. Cheever, T. C. Martin, C. D. Shain, C. E. Stump, Joseph Barré, E. F. Peck, C. O. Baker, Jr., E. E. Bartlett, H. D. Stanley, J. H. Herrick; *committee on membership*, C. H. Barney, Geo. T. Manson, J. C. Chamberlain, S. S. Wheeler, Joseph Wetzler.

THE MAGNETIC CLUB.

This club has just begun the practice of making printed records of its meetings. The first issue is very interesting and contains some personal reminiscences of President Lincoln by Mr. A. B. Chandler, the inaugural address of Mr. Edward C. Cockey as president of the club, and some manly advice to the younger members of the telegraphic profession, by Mr. G. G. Ward.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Council, held on March 17, the following gentlemen were admitted to associate membership:

Greenberg, Adolph G. Salesman, Fort Wayne Electric Co., 115 Broadway, New York City, 90 Pierrepont St., Brooklyn, N. Y.
Harrington, Walter E. Managing electrician, Atlantic City Electric Railway, Atlantic City, N. J.
Tuttle, George W. Storekeeper, Sawyer-Man Electric Co., 510 West 23d St., New York City.

At the regular monthly meeting which followed at 8 p. m., Mr. J. J. Carty, the electrician of the Metropolitan Telephone & Telegraph Co., read a very interesting and suggestive paper on "Inductive Disturbances in Telephone Circuits," which was followed by an animated discussion on the subject.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

Mr. A. J. Corriveau, of Montreal, was in New York last week making further arrangements for the meeting of the National Electric Light Association in Montreal next August. The Windsor Hotel will be the headquarters of the convention and a large exhibit of electrical goods and apparatus will be made in the Victoria Rink adjoining. Local committees are already being organized, and there is promise of hearty interest and cordial hospitality in every direction. The Canadian papers are devoting their space liberally to the matter, and the indications are already numerous that the convention will not only be a delightful summer episode, but an occurrence productive of the greatest benefit to both countries.

ELECTRICAL PROGRESS IN 1890.

The next regular meeting of the New York Electrical Society, on Friday, March 27, at 8 P. M., will be held by kind invitation at the Electric Club, No. 17 E. 22nd street, this city.

Mr. Joseph Wetzler will deliver a lecture on "Electrical Progress in 1890," in which he will devote particular attention to the practical advances which have been made during the past year.

The meeting will be one of special interest, due to the fact that many prominent inventors will be present to describe in person, and with the aid of models, the improvements made by them. Among the inventors who will assist, we may mention Nikola Tesla, P. B. Delany, J. C. Chamberlain, J. J. Carty, C. O. Mailloux, F. J. Patten, J. C. Henry, Dr. W. E. Geyer, W. H. Bristol, G. W. Walker, F. B. Crocker, and others. The lecture will begin promptly at 8.

The subjects touched upon will embrace the departments of Electric Lighting, Continuous and Alternating Motors, Thermo-Magnetic Generators, Telegraphs, Telephones, Electric Measurement, Primary and Storage Batteries, Electric Railroading, etc.

PITTSBURGH ELECTRIC CLUB.

Our Pittsburgh correspondent writes us that the electrical people of that city held a meeting on Thursday, March 19, and carried out a scheme that has been under discussion for some time, in the organization of an electric club.

The subjoined officers and board of directors were elected: President, Morris W. Mead; treasurer, James A. Rutherford; secretary, J. E. Hall; directors, H. McL. Harding, D. W. Dunn, I. H. Silverman, E. B. Kittle, H. E. Dillon, E. Ingold and E. B. Gawthrop. The organization was completed and a committee was appointed to take in hand the matter of securing a charter.

DEPARTMENT OF ELECTRICITY, BROOKLYN INSTITUTE.

The regular monthly meeting of the Department was held on Friday, March 20th, when, before an audience of 200 members and visitors, Mr. E. H. Cutler, the general manager of the Elektron Co., delivered a most interesting and instructive lecture on "Electric Motors and Their Construction." Mr. Cutler dwelt with much emphasis and force upon the essential features of lamination and slow speed, and illustrated their importance very clearly. He also accompanied his lecture by diagrams and by details of the materials employed in motor construction. He made an excellent display, too, of the Perret motors in various sizes up to 4 h. p. and showed how readily they lent themselves to every class of work necessitated by modern industry. The lecture was followed with the closest attention, and was one of the best of the admirable series with which the Department has gratified its members this season.

Patent Notes.

ELECTRIC SNAP SWITCH.

The issuance of a patent to E. H. Johnson, entitled "Electric Switch," No. 448,431, March 17, 1891, filed March 27, 1885, terminates one of the most hotly contested patent applications witnessed in the U. S. Patent Office. This patent is said to have had more interferences declared on it than any other ever before in the office. It is claimed to cover substantially any switch for controlling electrical circuits in which a spring is put under tension by the movement of the handle, and when the tension is at the maximum point acts upon the moving contacts independent of the handle and throws the moving contacts in one direction or the other with a quick powerful movement. This is the principle embodied in a large number of snap switches now in general use. It is understood that Mr. Johnson intends to enforce his rights in the matter.

THE CROWDED STATE OF THE PATENT OFFCE.

A special dispatch to the *Evening Post*, from Washington, of March 12, says:—In view of the overcrowded condition of the Patent Office, to which reference has been made previously in these despatches, the project has been mooted lately of destroying a large share of the copies still preserved of the older patents, so as to make room for the new ones. Commissioner Mitchell is reported to be somewhat impressed by the suggestion. From other sources, however, comes the strongest opposition. Patent attorneys and inventors all over the country are continually sending in their requests for copies of old patents, not merely individually, but as parts of sets concerning certain special subjects. To destroy these old copies in any quantity would cripple the office in its efforts to supply such demands; and in case the run upon any class of patents became large, the Government would be put to the expense of reprints. Finally, there seems to be no legal authority for the proposed destruction. The law requires the printing of a certain number of copies of each patent, and the sale of these copies at a specified price, but nothing is said of the right of the Commissioner of Patents or any one else to destroy them; and in other Government bureaus, where a surplus of old papers has accumulated, the custom is to wait until a committee of Congress has condemned them and ordered them sold or destroyed.

The appropriation made by the last Congress for rent of quarters for the Land Office outside of the Patent-Office building is likely to fail of its intended effect, as the owners of the building in which the new offices were to be procured have refused to rent to the Government. Even in case outside space can be procured as desired, it is doubtful whether the land office will be forced, as it should be, to remove any considerable part of its present machinery wholly out of the Patent-Office building and leave room for the Patent Office to spread; or whether it will simply stretch itself out so as to occupy all its present space and the new quarters besides. The policy on which the Interior Department has been managed for years has been to give more and more latitude to the Land Office and crowd the Patent Office into a smaller and smaller corner, and the friends of the last-named bureau have become discouraged at the outlook.

Reports of Companies.

TRINIDAD-HEIMANN INSULATED WIRE CO.

Mr. J. O'Rourke has been appointed receiver of the Trinidad-Heimann Insulated Wire Co., of Liberty street, this city. The company has been endeavoring to carry on the business established by the old Callender Co., but has not done a large trade.

EUROPEAN WELDING CO.

The purchasers of the welding patents for Europe have agreed to pay $25,000 to have the time for final payment of the purchase money extended 60 days from March 1.

A BIG EDDY POWER TRANSMISSION PLANT.

The Eddy Electric M'f'g Co., of Windsor, Conn., has just closed a contract with the American Encaustic Tiling Co., Limited, of Zanesville, Ohio, for an electric power transmission plant aggregating 365 horse power. The dynamos will be 90 h. p. each, and the motors will range in size from 10 to 35 h. p.

THE ATLANTIC AND WESTERN TELEPHONE CO.

The Chicago *News* of March 18 has the following:—"The Atlantic and Western Telephone Company, incorporated yesterday with a capital stock of $5,000,000, proposes to utilize the patents taken out by Henry C. Strong, who claims to be the original inventor of the instrument. Strong has been a telegrapher and electrician for many years. He says that in 1875 he perfected an instrument upon exactly the same working principle as the one used by the Bell company. In 1877 he applied for a patent, but the department would not recognize his claims and he lacked the capital to push them. Since 1877 he has been seeking recognition, but he has lacked money to fight the powerful monopoly which secured the patent. At one time he had established several private lines in Chicago and had manufactured twenty-five receivers, all of which were forcibly seized by agents of the Bell company.

"Mr. Strong claimed and still claims a prior right to the invention, and he has interested several people who have faith in his claim. Lately he succeeded in getting a patent on a modification of his original telephone, and it is this instrument which the new company will manufacture. It proposes to do a general business and will maintain the right to use the patent now claimed by the Bell company.

"Henry P. Caldwell, George M. Porter and Edward B. Springer, of Chicago, and George M. Brinkerhoff, of Springfield, are interested in the new corporation."

DIVIDENDS.

THE THOMSON-HOUSTON ELECTRIC CO. has declared a dividend of $2.50 per share on series C. securities, payable March 18.

THE AMERICAN BELL TELEPHONE CO. has delared a dividend of $3 per share payable to stockholders of record March 26.

ELECTIONS.

NEWARK, N. J.—At the annual meeting of the stockholders of the Newark District Telegraph Company, directors were elected for the ensuing year as follows: T. T. Kinney, George W. Hubbell, F. T. Feary, W. C. Ward, E. Weston and Enos Runyon.

NORWALK, O.—At the annual meeting of the Norwalk Light and Power Company, John Young, of Chicago, was elected president; George Barney, of Sandusky, vice-president, and W. M. Carpenter, of Chicago, secretary and treasurer.

GLOUCESTER, MASS.—The sale of the Gloucester Street Railway was completed on the 9th instant, when the stock was formally transferred, and the following directors were elected: W. B. Ferguson, of Boston; Col. J. H. Cunningham, president of the Winnisimmet National Bank, of Chelsea, and Mayor A. D. Bosson, of Chelsea. Mr. Ferguson was elected president and Col. Cunningham vice-president and general manager. President Ferguson states that the new management will enlarge and improve the service. The main line will be equipped with electricity immediately. The scheme of extending the road has not been completed, but a line to Lanesville, a distance of seven miles, will doubtless be built this summer, and other extensions may be made.

FALL RIVER, MASS.—At the annual meeting of the Fall River Electric Light Co., the following officers were elected for the ensuing year: Clerk and treasurer, Owen Durfee; directors, F. S. Stevens, J. D. Flint, W. H. Hathaway, E. L. Anthony, F. O. Dodge, O. S. Hawes.

The financial statement was as follows:

ASSETS.	
Construction accounts	$84,620.84
Cash and accounts	7,834.84
Miscellaneous	32,487.43
	$124,743.11

LIABILITIES.	
Capital paid in	$102,200.00
Bills and accounts payable	20,739.87
Profit and loss	1,803.24
	$124,743.11
Receipts, all sources	$31,989.88
Expenditures	24,118.94
Net earnings	$7,870.94

STOCKS AND BONDS.

ST. LOUIS, MO.—The stockholders of the East St. Louis Electric Railway Company met last week and voted to issue $15,000 of 5-15 bonds bearing 6 per cent. interest. The main line has already been completed and has done a paying business since the opening day. The branch line to the Little rolling mill is being rapidly constructed.

SAVANNAH, GA.—A meeting of the stockholders of the Ft. Meade, Midland and Avon Park Telephone Company was held at Avon Park recently when the company was organized and the following board of directors elected: E. W. Dawson, Geo. Edmiston. W. A. Evans, J. C. Burleigh, John C. Williams. The stockholders decided, by unanimous votes, that the capital consist of forty-five shares, of $25 per share, and that the directors be instructed to make a contract to finish the line at once. The following officers were elected: E. W. Dawson, president; Geo. Edmiston, vice-president; W. A. Evans, treasurer; J. C. Williams, secretary. The line is in process of construction.

OGDEN CITY, UTAH.—The Ogden City railway was sold at trustee's sale on March 5th. The price realized was $85,000, and it was bid in by L. R. Rhodes through H. M. Beardsley, attorney for the Jarvis-Conklin Mortgage Trust Company, of Kansas City, Missouri. The original debt of the road was $80,000, held by the Jarvis-Conklin company, who not only have borne the running expenses of the line, but have expended a large amount of money in equipping it with electrical appliances. About six miles of wires have been placed in position on the most important streets. Other improvements will be made as soon as the condition of the streets permits. A large power house will be built at once. Mr. Rhodes has been given temporary charge of the lines.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of March 21, 1891, from New York, Boston and Washington; Pittsburgh, March 20.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	79¼	Edison Gen. Elec. Co.	100
American Tele. & Cable	81	Edison Gen. Co. Def'd	...
Contl. & So. Amer.	....	Consol'd Elec. Lt. Co.	....
Mexican		Edison Illu'g Co. N. Y.	..
Com. Cable Co.	104	U. S. Elec. Lt. Co.	....
Postal Tel. Cable	....	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	43¼	Ft. Wayne Co.	12¼
" Pref'd	25¼	Am. Bell	....
" Series C	29¼	Erie	48¼
" " D	6¼	New England	50
" Int. Co.	....	Mexican	.85 cts.
Thomson Welding Co.	....	Trop. American	.70 cts.
Thomson Eu. Welding	....	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt. (Wash.)	170
Ches. & Pot. Telephone	57¼	Eck. & Sold. Home Elec. Ry.	56¼
Amer. Graphophone	5¼	Georgetown & Tenallytown	60

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co.	11¼

Legal Notes.

W. U. NOT RESPONSIBLE FOR LIGHTNING.

In the damage suit of Albert J. Angus against the Western Union Telegraph Company, at Superior, Wis., a verdict for the defense of no cause of action has been returned. This was a suit brought by Angus as a result of a stroke of lightning received by the plaintiff while running a hotel at Pike Lake eighteen months ago. The company had an office in Angus' hotel, and when the instruments were taken out, failed to ground their wires. Angus set up the allegation that the wires attracted the heavenly fluid to his havoc. The case has attracted the attention of electricians and telegraph officers all over the country.

THE RESPONSIBILITY OF TELEGRAPH COMPANIES.

In the case of Luke M. Emerson against the Western Union Telegraph Company for damages under section 2,725, revised statutes of 1889, Judge Hughes, of the Pike county circuit court, Missouri, has rendered a decision which, if sustained by the higher court, invalidates the statute. Emerson sued for the penalty of $200 for the failure of the company to deliver a telegram sent from this city to Nashville, Ill. The defendant demurred on the ground that said section so far as it applies to telegraphic business beyond the borders of Missouri is unconstitutional in that it undertakes to regulate interstate commerce, and is, therefore, in violation of the constitutution of the United States, conferring on congress the regulation of interstate commerce. Judge Hughes sustained the demurrer. As the principle involved in the case is of great importance, Clark & Dempsey, the plaintiff's attorneys, will take the case to the higher courts, and ultimately to the supreme court of the United States, if necessary.

ALLEGED UNJUST TAXATION IN VERMONT.

Persons who are interested in some of the smaller telegraph lines of Vermont are complaining of an injustice done them by the Legislature of the State in assessing them, under the corporation tax law, 10 per cent. of their gross receipts, when telephone companies are assessed but three per cent. They assert that the telephone companies are making more money than the smaller telegraph companies, and that the tax imposed upon the telegraph companies is outrageous. The law is made retroactive, and the tax is assessed upon business done since June 30, 1890.

ST. LOUIS, MO.—The Adams Electric Company, incorporated under the laws of Illinois, with a capital of $5,000,000, has perfected its organization by the election of W. Slaughter as president. The company proposes to enter suit against all the street railroad companies infringing on the Adams patents. The first suit will probably be brought in Boston. Eminent counsel is retained and an attempt will be made to wrest the patents from such corporations as the Thomson-Houston, Van Depoele, Bentley-Knight, Westinghouse, Short and Wenstrom.

Should the Boston suit be decided in their favor the Adams Company will then obtain writs of injunction restraining all other companies from use of the patents.

TUNNEL LIGHTING BY ELECTRICITY.

At the investigation of the accident in the Fourth Avenue tunnel, last week, Mr. Augustus Whiting, who had examined the manner of illuminating the Hoosac Tunnel, testified that he had passed through that tunnel on a locomotive and found that, owing to electric lights placed forty feet apart, and about five feet above ground, it was as bright as day. There were 1,250 of these lights, and, owing to the fact that coke was used in the engine furnace, the atmosphere did not become murky at all. He could always see a long distance ahead.

Engineers with whom he conversed told him that while the company had fought against the system at first, it was now admitted to be perfect, and no accidents had happened since it had been put in. The cost was about $30 per diem.

An engineer running a locomotive on the Harlem road was called, who testified that the street electric lights at Motthaven blinded him. He did not mention, however, that those are arc lights, while the lamps in the Hoosac Tunnel are incandescents.

BOOK NOTES.

The Cassell Publishing Co. is issuing a new work by Mr. Robert Grimshaw, the engineering expert, entitled "Hints to Power Users." It will contain a large amount of valuable information as to selecting, buying, placing and operating every part of a power plant, and touches on all the many details of such an installation. It will be published at $1.00.

Appointments, Etc.

MR. F. SARGENT, of Chicago, has been selected by Commissioner Barrett, as his electrical engineer for the electrical department of the Columbian World's Fair. Mr. Sargent has had a long experience as a marine engineer and later as one of the engineers of the Edison General Co. He has lately been in practice for himself in Chicago, as a consulting steam and electrical engineer.

MR. C. STEWART HUNTER has severed his connection with the New York Safety Insulated Wire & Cable Co., and joined the forces of the Bishop Gutta Percha Co.

PRESIDENT DUNSTON, of the Connecticut Motor Co., has been made general superintendent of the Thomson Electric Welding Co., at Lynn, Mass.

MR. C. K. WESTBROOK, manager of the Thomson-Houston isolated lighting department, in Philadelphia, has been given charge of the business of the Thomson-Houston Motor Co., with headquarters at 509 Arch street. Mr. E. D. Mullen has been put in charge of the railway department at the same address.

MR. FRED E. ALEXANDER, one of the best known electrical experts in New England, has connected himself with the Eastern Electrical Supply and Construction Co., 65 Oliver street, Boston. He will have charge of the central station department of this company.

MR. JOHN KENYON has returned to Philipsburg, Pa., to take charge of the electric light and steam heat plants in that place.

Personal.

MR. FRED CATLIN.

One of the best known telegraphers in the country is Mr. Fred Catlin, who has just resigned his position as chief operator of the Eastern Division of the W. U. Tel. Co., in New York, to take up the management of The Newspaper Press, which is an association for collecting and selling news. Mr. Catlin has a very creditable telegraphic record behind him, and is known as one of the best and swiftest operators ever seen in America. His method of handling the key is known as the "Catlin grip," and has long been approved by the most experienced men in the craft. Mr. Catlin has also made a phenomenal success of his Telegraphic Tournaments, the last of which will still be fresh in the minds of our readers. The Newspaper Press, we may mention, is backed by the Globe Press Association, a "plate matter" concern, of which Mr. W. J. Arkell, of the *Judge*, is president. The Newspaper Press being primarily the telegraphic arm of the Arkell Company, it may expect sufficient revenue at once from that concern to put it on a solid footing and enable it to push forward free from the handicapping that similar organizations have usually encountered at their outset.

UNSUSPECTED MERIT OF THE TROLLEY SYSTEM.

The recent strike of cloakmakers in New York city, and the attending troubles at Jamaica, L. I., have resulted in one good thing for the overhead trolley system. A lot of the riotous union men descended on a "scab" contractor at the latter place, and after wrecking his shop and throwing vitriol on his wife and child, decided to hang the contractor to an overhead trolley wire, and only gave up their plan when they discovered that the current was not strong enough to injure him. Those of them in the habit of reading the daily papers had been deluded into the belief that the railway current would reduce their victim to a state of innocuous desuetude more quickly than vitriol would. They know better now.

TELEPHONING BETWEEN LONDON AND PARIS.

The inaugural telephone talk between London and Paris by the new land and sub-marine cable line on March 18 was a notable event. Mme. Roche, wife of M. Roche, Minister of Industry and the Colonies, had the honor of uttering the first words over the new line. M. Roche then held a conversation with Mr. Henry Cecil Raikes, the Postmaster-General of Great Britain. M. Roche said that he hoped the telephone line would form a fresh link of friendship between Great Britain and France. The Earl of Lytton, the British Ambassador at Paris, and M. de Selves, the Director-General of the Posts and Telegraph Department, also spoke to Mr. Raikes by telephone. The results are very satisfactory, the talking being quite clear and audible.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 17, 1891.

Alarms and Signals :—

Call System, L. Digeon, 448,322. Filed Nov. 1, 1887.
Adapted for fire alarm, police or any other call system. Includes the use of telephones.

Barber's Indicator, S. P. Watson, 448,392. Filed June 7, 1890.
Details of electro-magnetic and mechanical devices.

Clocks :—

Electric Alarm Clock, E. M. Edgerton, 448,325. Filed Nov. 21, 1889.
Details of construction and circuits.

Circuit Closer for Clocks, H. A. Chase, 448,291. Filed Sept. 6, 1889.
Employs means for causing a large amount of surface of one member of the circuit closer to make contact with the other member of the circuit closer in a short space of time ; a sliding or rubbing contact is employed.

Conductors, Conduits and Insulators :—

Insulator, G. K. Wheeler, 448,395. Filed Nov. 21. 1890.
A cone insulator consisting of two non-conducting portions, the upper being cone-shaped to receive a hood ; the two portions are screwed together and each carries a metal hanger, one projecting above the cone-shaped part and the other below the hood.

Electric Cable, W. A. Conner, 448,604. Filed Nov. 8, 1890.
Consists of a number of conductors each covered with a fibrous insulating material, grouped to form a core which is provided with water-proof covering and a sheathing capable of withstanding a high temperature, and an exterior protective coating of lead.

Distribution :—

Electric-Lighting System, E. Thomson, 448,279. Filed May 21, 1886.
Relates to means for automatically regulating the flow of current to translating devices arranged in multiple arc upon a line on which the current supplied is of nearly uniform amount, such as an arc-light circuit supplying a number of groups of incandescent lights in series. Consists essentially in the combination of an electro-magnet adapted to move its armature step by step with definite changes in the strength of the magnet, and so connected as to be in derived circuit around the lights, with means whereby the successive movements of the armature introduce definite resistances equal to the number of lights that may be extinguished by accident or otherwise.

Dynamos and Motors :—

Method of and Apparatus for Developing Mechanical Motion From Electrical Energy, R. Eickemeyer, 448,326. Filed July 20, 1888.
An electric motor without commutators. Resembles Fonvielle and Lontin's "tourniquet electrique."
Claims 1 and 10 follow :
1. The method of developing mechanical motion from electrical energy, which consists in intermittingly varying the polar conditions of an electro-magnetic field and in like manner varying induced polar conditions in a movable element by correspondingly varying separate supplies of field-exciting energy derived from any suitable source of electricity.
10. In an electric motor, the combination, substantially as hereinbefore described, of a magnetizable armature, an electro-magnet having separate sets of exciting helices coupled to separate electric circuits, and means for separately supplying electric energy to said helices under impulsive conditions and causing said sets of helices to successively and alternately develop variable polar conditions in said magnet and to sequentially develop in the armature correspondingly varied but opposite polar conditions.

Commutator Brush, K. G. Frietsch, 448,331. Filed June 28, 1890.
Has a carbon or other suitable contact piece, automatically fed forward as it wears away by an adjustable spring pressure ; the current passes from the carbon contact near the commutator surface to a second brush of copper or other good conductor.

Commutator-Truer, D. McGenniss, 448,540. Filed June 10, 1890.
An appliance for trueing or rectifying commutators.

Electro-Magnetic Motor, E. D. Chaplain, 448,608. Filed Aug. 21, 1889.
Mechanism designed to facilitate the adaptation of electric motors to driving individual machines in a factory or to drive a line of shafting ; armature arranged to revolve about the axis of a central shaft ; comprises a system of differential of gearing.

Driving Mechanism for Dynamo-Electric Generators, S. H. Short, 448,308. Filed Nov. 6, 1890.
Specially adapted to driving dynamos that are coupled directly to the engine. The dynamo is mounted on an insulated base. The driving shaft is in two parts rigidly connected together, one supported on the engine and the other carrying the armature ; the two parts of the driving shaft have an insulating section between them.

Lamps and Appurtenances :—

Electric Arc Lamp, J. W. Easton, 448,418. Filed March 20, 1890.
A brake wheel controls the movement of the carbon rod and a spiral spring bears against the periphery of the brake wheel ; one end of the spring being secured to a fixed portion of the frame and the other end being connected to the core or armature of a solenoid or magnet. The tension of the spring varies with changes in the resistance of the lamp circuit.

Electric Arc Lamp, K. Kurmayer, 448,351. Filed Sept. 15, 1890.
Details of design and construction of an arc lamp employing carbons converging or in an angular position with each other.

Measurement :—

Electric Meter, E. Thomson, 448,280. Filed Nov. 20, 1890.
For registering the current in a constant potential circuit. A motor meter in which movement is retarded by a copper disc or equivalent closed circuit conductor rotating in a magnetic field of varying strength. The field is so proportioned to the torque of the motor that when no translating devices are in circuit the damping effect will suffice practically to stop the movement of the motor.

Miscellaneous :—

Electric Sad Iron, C. E. Carpenter, 448,317. Filed June 21, 1890.
Designed to confine the heat to the working surface ; employs a heat insulating material between the body and plates.

Support for Electric Wires, C. A. Lieb, 448,216. Filed Nov. 19, 1890.
An insulated supporter for overhead wires particularly adapted for trolley-wires. Comprises a metallic body part and a metallic nut within and between insulating material and a threaded ring engaging with threads on the body part for holding the insulating material in place.

Electric Type-Writing Machine, E. J. Silkman, 448,271. Filed April 7, 1890.
Employs electro-magnetic apparatus for reciprocating the actuating-frame and turning the type-wheel.

Electrically Controlled Valve, J. V. Stout, 448,273. Filed Jan. 31. 1890.
Relates to devices of the class in which a thermostatic circuit-closer is employed with electro-magnetic apparatus for controlling a heating medium.

Electric Temperature-Regulator, J. V. Stout, 448,274. Filed Jan. 31, 1890.
Similar in purpose to the next above.

Segmental Resistance-Board, G. D. Hand & O. P. Sells, 448,338. Filed Aug. 11, 1890.
Relates to segmental switch-boards for controlling electric lights in theatres and other public places, and designed especially for compactness and convenience of manipulation.

Support for Electric Cables, H. B. Nichols, 418,359. Filed Nov. 15, 1890.
A clip or clamp for affixing and supporting electric cables upon the walls of buildings or on any other fixed support.

Electric Switch, R. D. Pratt, 448,365. Filed July 7, 1890.
A switch operated by a push-button, which is pressed both to open and close the circuit ; shown in the patent as adapted to an electric lamp-socket.

Vapor-Engine, D. S. Regan, 448,369. Filed Nov. 6, 1890.
Employs electricity for igniting the gas or vapor.

Electric Switch, E. H. Johnson, 448,431. Filed March 27, 1885.
Claim 1 follows :
A hand-switch for making and breaking an electric circuit having, in combination, a moving contact-piece, a spring connected with said moving contact-piece by a loose connection, and a free handle connected with such spring and acting by its movement to strain the spring and to release it without making or breaking the circuit, whereby the spring will then throw the moving contact-piece by direct spring action to the end of its movement, and the circuit will be made or broken by a spring-snap action.

Electric-Wire Support and Cut-Out, E. R. Whitney, 448,468. Filed Nov. 4, 1890.
A wall or ceiling support and cut-out.

Method of Making Plated Wire, C. R. Smith, 448,594. Filed Dec. 24, 1890.
Deposits electrically upon a metallic rod a thin film of another metal, then places upon the electro-plated rod a metallic shell, then subjects the whole to heat sufficient to fuse the electro-deposited metal, thus soldering the shell to the rod; then reducing the rod to a wire.

Railways and Appliances :—

Electric-Motor Truck, F. O. Blackwell, 448,199. Filed June 17, 1889.
Claim 1 follows :
The combination, with an electric motor having a framing journaled upon the axle of a vehicle and carrying gears connecting the armature shaft with the axle, of a framing independent of the car body attached to the journal boxes of the truck outside of the wheels, supporting the free end of the motor and provided with a cushion modifying its action upon the journal boxes.

Motor-Suspension for Railway Work, E. W. Rice, Jr., 448,260. Filed Aug. 15, 1889.
Consists, chiefly, in the provision of a frame sleeved to the car-axle and having journal-bearings for the armature axis and the axes of any intermediate gear between the armature and car-axle ; the motor field-magnet is supported on the armature axis.

Tail-Light for Railway-Trains, A. W. Berne, 418,315. Filed Mar. 14, 1890.
A metal arm on the axle of a car and rotating with it makes and breaks circuit for flashing the tail-light, thus indicating whether the train be moving or no.

Electric Railway, J. B. Entz, 418,328. Filed July 3, 1890.
Consists chiefly in the employment of a continuous stationary armature extending throughout the length of the track ; field-magnets carried by the car in proximity to the continuous armature are energized by the armature, through brushes or other contact devices. The car or vehicle is thus pulled directly by a horizontal force.

Electrical Street and Station Indicator, F. H. Soden, 418,378. Filed Mar. 20, 1890.
For street and other railway cars. Source of electricity carried upon the car. A trolley suspended from the car is operated at desired points along the line for closing and opening circuits to the electro-magnetic indicator.

Underground Conduit for Electric Railways, R. A. Stewart, 448,461. Filed Oct. 4, 1890.
Has a slot extending sidewise into the conduit for the passage of the trolley arm ; designed to prevent the access of mud or other obstruction to the trolley contacts ; the trolley or brush bears upon the under surface of a conductor secured to the upper inner surface of the conduit.

Electric-Railway Motor, C. J. Van Depoele, 448,561. Filed Oct. 22, 1889.
The motor comprises a stationary part or field which is annular or cylindrical in form with a continuous iron core. The armature is shown as directly upon the car axle. The invention includes means for distributing supply current to the motor or motors.
Claim 15 follows :
The combination, with a moving vehicle or vehicles, of one or more motors applied to propel the same, means actuated by the movement of the vehicles for distributing supply current to the motor or motors, and a series of motors all supplied by a distributer or distributers controllable from a single point, and a single set of reversing apparatus for the entire series.

Electric Locomotive, C. J. Van Depoele, 448,562. Filed May 26, 1890.
Claim 1 follows :
An electric locomotive comprising the two independent axles of a car truck, a single motor disposed between and separately spring supported upon said axles and provided with a suitable pinion upon its armature shaft, and dynamometric gears on each axle, said gears being all in direct engagement with the armature pinion.

Electric-Railway System, C. J. Van Depoele, 448,563. Filed Dec. 13, 1890.
Improvements upon the same inventor's prior patents, Nos. 434,684 and 434,685, Aug. 19, 1890.
Claim 1 comprises :
A field-magnet and an armature having a sectional winding and commutators therefor and short circuiting brushes thereon adjustable with relation to the inducing poles of the field magnet to control the power and direction of rotation of the armature, a distributer receiving a continuous supply current and converting it into alternating currents.

Electric Transportation System, S. S. Wheeler and C. S. Bradley, 448,598. Filed July 29, 1889.
Claim 1 follows :
An electric transportation system comprising a movable vehicle or car carrying a magnetic mass, a guide way for said car and an inductor along the guide way, the mass and inductor being continuously in inductive relation and connection with a source of energy for propagating along the guide way a succession of polar waves, whereby a movement of translation will be imparted to the car by the successive waves.

Electric Railway, R. M. Hunter, 448,618. Filed Sept. 1, 1890.
Two tracks have their rails looped at one end and electrically connected together and with one pole of the generator; a separate suspended conductor is provided for each track and they are looped to correspond with the tracks and connected together and with the other pole of the generator.

Apparatus for Ventilating Railroad Cars, R. J. Wilson, 448,401. Filed Nov. 25, 1889.
The ventilating devices are operated by compressed air or fluid controlled by electro-magnetic apparatus.

Trolley Support for Electric Cars, B. F. Crow, 448,505. Filed July 12, 1890.
Designed to remove the weight from the central portion of the car roof. Employs a truss composed of a compression member and a tension member, their ends engaging.

Electric Railway, R. M. Hunter, 448,523. Filed March 18, 1886.
Line conductors are arranged in long sections with a generator for each section; controlling devices are actuated by the strength of current in one section for controlling the supply of current to the next section.

Telephones and Apparatus:—

Telephone, S. D. Field, 448,329. Filed May 25, 1889.
Claim 1 follows:
A telephone having its diaphragm supported between polar extensions of the two limbs of a magnet and magnetically connected at or near the rim, with an iron bridge connecting the poles of the magnet, each of the polar extensions being provided with a line coil wound to develop like polarities at the confronting ends.

Obituary.

CHARLES S. THOMPSON.

Charles S. Thompson, superintendent of the American District Telegraph Company in Brooklyn, died at his home in Brooklyn, on March 17, of apoplexy. His first attack of the disease followed closely on his witnessing the death of Lineman Feeks on Chambers street, in 1889, his nervous system sustaining a shock at the time from which he never recovered. Mr. Thompson was born at Chester, Orange county, N. Y., fifty years ago. He was in the telegraph business nearly all his life, having engaged in the construction of lines for the old United States Company in Virginia in 1865. He entered the service of the American District Telegraph Company March 12, 1872, and was appointed superintendent May 5, 1878. Two sons and two daughters survive him.

A NEW ARC LAMP.

A new arc lamp has been invented by a Pittsburgh patent attorney, which, if all the claims made for it can be sustained, says our Pittsburgh correspondent, will undoubtedly prove a good thing for the inventor. The claims set forth for the new lamp are that it will produce a stronger light than the ordinary arc lamp, that it is more simple in its construction and cheaper as to cost. But its greatest point of excellence is said to be its endurance. It is stated that the new lamp will burn continuously without requiring the renewal of carbons for 500 hours. This prolonged endurance is made possible through the peculiar construction of the carbons, which, instead of the ordinary pencil-shape, are made in the form of miniature emery wheels, four and eight inches in diameter, one wheel of each size being used for each lamp. They are placed at right angles, the larger over the smaller one, and by an automatic electrical arrangement inside the lamp they are kept in constant motion. A company is to be formed to bring the new lamp on the market.

CLEVELAND TRADE NOTES.

THE FORD & WASHBURN ELECTRIC CO.—This wide awake concern have had a phenomenally rapid growth in their business and are now very busy turning out their ventilated armature motor of all sizes and generators up to 500 light capacity, several of which large size they are building. Burn-outs are an unknown quantity with this armature, which is self ventilating and always cool, and the high efficiency, remarkable durability and fine workmanship of all their machines is very noticeable. They have issued a handsome catalogue, of which purchasers of motors and dynamos should not fail to secure a copy.

THE BUCKEYE ELECTRIC CO., of Cleveland, are largely increasing their capacity for the manufacture of their well-known incandescent lamps. They are now bringing out a perfected lamp of striking merit possessing many new and valuable features, amongst which the chief is an entirely new filament of great durability, very economical and of enormous tensile strength for so delicate a part as the filament of an incandescent lamp.

DAYTON, O.—The Dayton Globe Iron Works have furnished six 66 inch wheels to the Economy Light and Power Co., of Joliet, Ill.

LOCKPORT, N. Y.—Mr. David Maloney, formerly of Maloney & Palmer, has opened an office for electrical supplies and work on the ground floor of the Hodge Opera House. He will carry a full stock and will undertake all classes of work in his line.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"An advertisement should not be a mere jumble of big types confusing to the eye, but an irresistible statement of big opportunities convincing to the pocket."

ELECTRIC MERCHANDISE CO.

The above company, of 11 Adams street, Chicago, having become selling agents for the Tramway Rail Co., of Pittsburgh, Pa., it has issued announcements to that effect, and is now prepared to fill all orders for girder rails, tram rails, tee rails, chairs, tie plates, splice bars, frogs, switchings and other details of street railway equipment. The company has also distinguished itself by adopting a new monogram trade mark, which is intended to show how remarkable is the vivifying influence of Chicago on even the deadest of dead languages. Mr. W. R. Mason has a very successful style of dressing up "dry facts."

THE INSULITE SOCKET.

With regard to the "Insulite" lamp socket, which is now exciting so much attention, it should be stated that the inventor is Mr. Alfred Swan. Currency has been given to the report that it owes its paternity to Mr. T. G. Roebuck, the general sales agent of the company, but that gentleman has modestly hastened to disclaim the honor thus conferred upon him, finding glory enough in the large orders he has already begun to secure for it.

SILICON BRONZE TROLLEY WIRE.

This wire, manufactured by the Aluminum Brass and Bronze Co., of Bridgeport, Conn., combines strength, ductility, wearing qualities, and conductivity in a remarkable manner. The size usually used for trolley wire, No. 4, B. W. G., has a tensile strength of 80,000 pounds per square inch, and a ductility of over 30 twists in six inches. It has been found to outwear large wire of hard drawn copper, and on the street railway in Paducah, Ky., where it has been in use for the past eight months on curves of less than 50 ft. radius, it still shows no wear, and is in as good condition as when first put up.

On the Jamaica and Brooklyn Railroad, a large tree recently fell across one of these wires and held it to the earth under a tremendous strain. When the tree was cut away, the wire immediately sprung back into position, and has given no trouble since.

The general manager of the Erie Electric Motor Co. writes that he finds by actual measurement, that the wire in use on his road has not worn more than $\frac{1}{64}$ of an inch in nearly two years.

In addition to the roads above mentioned, silicon bronze wire is employed on the lines of the Sioux City Street Railway Co.; the Atlantic City Electric Railway; the Troy and Lansingburg; the Citizens' Rapid Transit Co., of Nashville, Tenn.; the Piqua, O., Street Railway Co.; the Lindell Railway Co., of St. Louis; the Laredo, Texas, Improvement Co.; the Binghampton, N.Y., Street Railway Co.; the Steubenville, O., Street Railway Co.; the North Avenue Railway Co., of Baltimore; the Keokuk, Iowa, Railway and Power Co.; the Salt Lake City R. R. Co.; the Chamberlain Investment Co., of Fort Worth, Texas; the West Bay City, Mich., Electric Street Railway Co.; the Erie Electric Motor Co.; the Marlborough, Mass., Street Railway Co.; the Eau Claire, Wis., Street Railway, Light and Power Co., and the Tramvia Del Chiantia Dei Colli, of Florence, Italy. All of these companies speak of the silicon bronze trolley wire in terms of the highest praise and are enthusiastic in their recommendation of it as the most serviceable wire for the purpose now in use.

WESTON ENGINES IN DEMAND.

The Weston Engine Co., of Painted Post, N. Y., reports business as brisk. They have sold recently of their Weston automatic engines two 75 h. p. and one 60 h. p. to J. R. Kemp, of Washington, D. C.; two 65 h. p. to Liberty Manufacturing Co., Savannah, Ga.; one 60 h. p. to S. Carson & Son, Riverton, Va.; two 15 h. p. and one 20 h. p. to The Steuben Electric Manufacturing Co., Hornellsville, N. Y.; two 15 h. p. to D. H. Darrin, for driving the electric plant of one of the finest buildings in Buffalo; one 20 h. p. to The Merrell Fabric Glove Co., Hornellsville, N. Y.; one 100 h. p. to the Weston Furnace Co., Manistique, Mich., and one 25 h. p. to Geo. Rightmire, Willawanna, Pa. They have also furnished horizontal tubular boilers for almost all of the above engines.

This company has lately secured as superintendent Mr. C. K.

Longenecker, who was formerly connected with the Harrisburg Foundry and Machine Department. He has adapted their engine especially to the electric lighting and railway business, and they are now making some bold bids for recognition in that line.

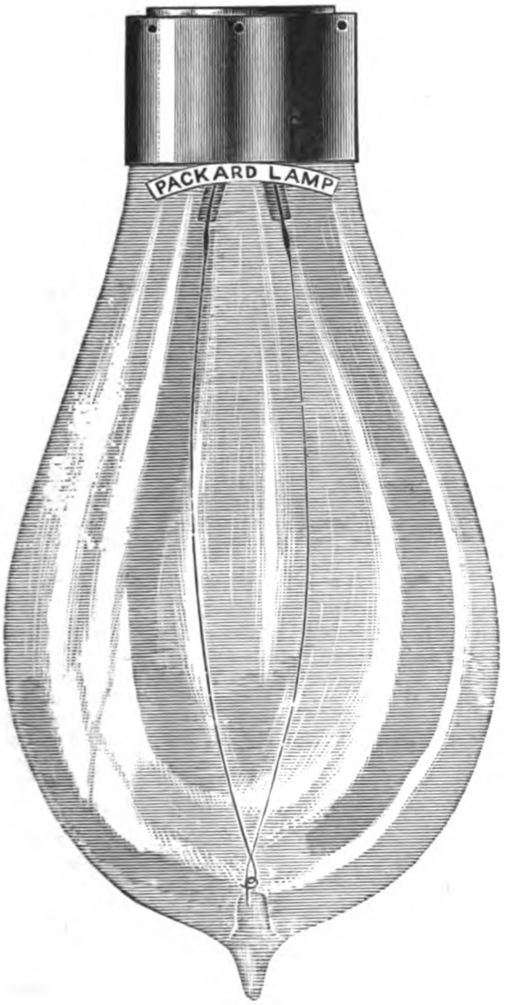
A USEFUL PAMPHLET ON BELTING.

C. W. Arny & Son, Philadelphia, have prepared and published a paper on the subject of transmission of power by belting, which will be of interest to all users of belting. The fact that C. W. Arny & Son have had unusual facilities for observation on this subject due to their long connection with belting interests as manufacturers and operators, makes the paper of especial value and it may be had from them on application.

THE NEW PACKARD INCANDESCENT LAMP.

We illustrate in the accompanying engraving the new Packard high-grade incandescent lamp, manufactured by the New York & Ohio Company, of Warren, Ohio. In producing this lamp, the aim of the manufacturers has been to make the best lamp possible regardless of cost, and this lamp is presented, not as a new or experimental one, but, as the perfection and result of seven years' experience in the commercial manufacture of lamps on a large scale.

In all their high-volt lamps from 90 volts and upwards, the carbon is supported at the tip by means of an inwardly projecting glass stem carrying a platinum hook. This prevents any drooping or vibration of the carbon, removing all danger of breakage from these causes and adding greatly to the symmetrical appearance of the lamp. The low volt lamps having a shorter carbon do not need this support, and it is therefore omitted.



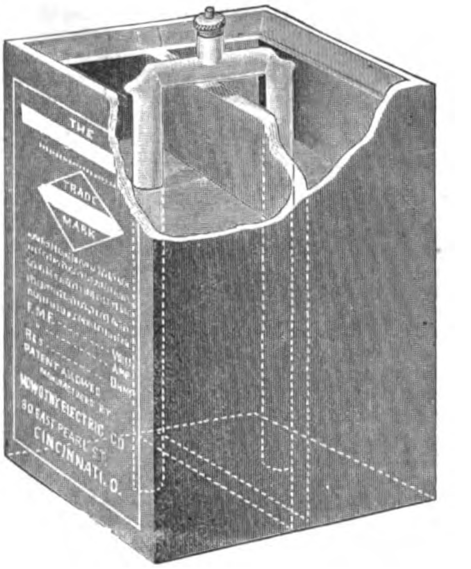
The Packard "High Grade" Incandescent Lamp.

Aside from the intrinsic value of the secret process of manufacture employed, the workmanship and materials are of the very best, and no molded glass or second-hand shells are used. Although in business but a short time, the company have an excellently equipped factory with a large force of experienced hands, and report business very good, while their lamps are everywhere giving great satisfaction.

THE MULTIPLE BATTERY.

The accompanying illustration shows the new "Multiple Battery" for telephones, electric bells, gas lighting, burglar alarms, annunciators, electric clocks, medical apparatus, and for all purposes where an open circuit battery can be used. It is manufactured by the Nowotny Electric Co., of Cincinnati, O., who claim for it high voltage and double the power of any other open circuit battery, together with less internal resistance.

The outer cell of the battery is composed entirely of carbon, with a carbon diaphragm dividing it into two compartments, making it equivalent to two cells coupled in quantity. The result is that a very large carbon surface is exposed to the action of the chemicals. The voltage is that of the very best cell, and the internal resistance is less than that of the average cell, with the quantity of two cells. The zincs consist of two pieces united at the top, one zinc entering each compartment, as shown. The terminals are electroplated with iridium, protecting the contacts from corrosion.



The "Multiple" Open Circuit Battery.

The battery contains an electrolyte of sal ammoniac diluted with water, and is ready for immediate use. The E. M. F. of this cell is 1.7 volt; current, 2 amperes; and resistance, .85 ohm.

THE "AMERICAN" ELECTRIC PASSENGER ELEVATOR.

Among the improvements introduced by Messrs. Behr Bros., the well-known piano makers, into their new building, No. 81 Fifth ave., this city, is an electric passenger elevator. This elevator, which was installed by the American Electric Elevator Co., of 15 Cortlandt street, New York, occupies a space of only 5 by 6 feet at the side of the elevator shaft in the cellar of the building, and operates with the greatest smoothness. In addition to the regular safety appliances, the elevator is equipped with a very simple arrangement by which the slightest slacking of the cable around the winding drum is followed by a cutting off of the current; this at once stops the elevator and thus avoids all danger from this source.

In this building the motor driving the elevator is in circuit with a separate meter and connected with the Edison street mains so that the exact consumption of current can be determined and charged for this service. In a recent letter Messrs. Behr Bros., after expressing their entire satisfaction with the operation of the motor, state that, as a matter of fact, it involved less expense for power than anticipated. This is strikingly brought out by the fact that the bill of the Edison Electric Illuminating Co., for current furnished to the motor between Jan. 31 and Feb. 28, 1891, amounted to only $5.62, the elevator running from 8 A. M. to 6 P. M.

CROCKER-WHEELER MOTOR CO.

The Crocker-Wheeler Electric Motor Company is soon to enlarge its establishment in West 14th street, this city, doubling the space it now occupies. This will enable it to have a large show room for exhibiting all sizes of Crocker-Wheeler perfected motors with their various applications, in operation, as well as a dust-proof department for the storage of finished motors and motor frames ready to be wound. The company find it necessary to carry a large number of motors unwound for filling special orders.

NEW DEPARTURE OF THE INTERIOR CONDUIT & INSULATION CO.

The extremely rapid growth and extension of the demand for tubes for interior wiring and for a great variety of details and fittings in connection therewith, has led the Interior Conduit & Insulation Co., of Broad street, New York, to take steps for the acquisition of such facilities as will enable it to engage in a general electrical manufacturing business. Inasmuch as its large new factory immediately adjoins that of the Bergmann Electric and Gas Fixture Co., it has become evident that it would be a good stroke of policy to absorb the latter concern and thus carry on the two businesses and the two factories, with corresponding economy in management and increase in profits. The Conduit Company has therefore secured an option on the Bergmann property, patents, machinery, etc., and steps are being actively taken to start the consolidated company in full operation. To effect the transfer, the Interior Conduit Co. is offering for sale $300,000 of its treasury stock, the subscription list to close April 4 at noon. The price is $75 per share. Of the $230,000 to be realized thus, $95,000 will be paid for the property acquired, and $135,000 will be used as working capital. The business which will be handled by the new concern is one of great scope, and the demand for its products is already very large. It need not be pointed out that the market for interior conduits is practically without limit, and that the company, as the pioneer in this line, is sure to reap a rich harvest from the conditions of the time which point indubitably to the universal use of ducts for interior work. The Interior Company has also some heavy work in immediate prospect in laying underground conduits for electric railways in leading cities. The Bergmann Co. has a progressive manufacturing business, and is engaged on work for the Western Union Co. and other electrical corporations, as well as making metal parts, etc., of the interior conduit system. Moreover, the consolidated company is to acquire the new patents of Mr. E. H. Johnson on electric railway appliances and motors, and will stand ready to develop any new apparatus of merit that may come along, whether designed by its own inventors and experts or brought to it for trial. The company will own over forty patents at its outset.

The officers of the present Interior Conduit and Insulation Co. are: E. H. Johnson, president; S. Bergmann, vice-president; F. A. Mason, secretary and treasurer; J. H. McClement, comptroller; E. T. Greenfield, electrician; E. W. Little, general manager, and Eaton & Lewis, general counsel. Messrs. H. Steers, C. E. Runk, S. Insull and F. J. Sprague are also directors.

THEY PREFER STORAGE BATTERY LIGHTING.

The Pennsylvania Company for Insurance of Lives and Granting Annuities, has ordered from the Electro Dynamic Company of Philadelphia, three series of 58 cells—total 174 cells—"15 L" type accumulators, with resistance cells, regulating switches, etc., complete, for lighting its building, No. 517 Chestnut street, Philadelphia.

The Pennsylvania company moved into their new building last summer, and for five months lighted their offices by means of the direct lighting system of the United States Company, changing then to the Edison system, taking the current from the mains in the street for three months, but finally concluded that the storage battery system, which they had had in operation in their old building, was superior to the direct system.

RECENT THOMSON-HOUSTON SALES.

The Thomson-Houston Electric Co. reports the recent sale of the following apparatus: *Arc plants:* Ashland, O., 50; Lowell, Mich., 50; Mansfield, Pa., 25; City of Chicago, Ill., 50; Elyria, O., 70; Louisville, Ky., 50; So. Chicago, Ill., 150; Greenville, Mich., 60; Lincoln, Neb., 150; Newport, Ark., 50; Joliet, Ill., 150; Arkadelphia, Kan., 30; Medina, N. Y., 50; Olathe, Kan., 50; Parsons, Kan., 35; Hyde Park, Ill, 50; Clinton, Mo., 50; Shelbyville, Mo., 50; Oshkosh, Wis., 50; Harrison, O., 35; Osage, Ia., 18; Farmville, Va., 30.

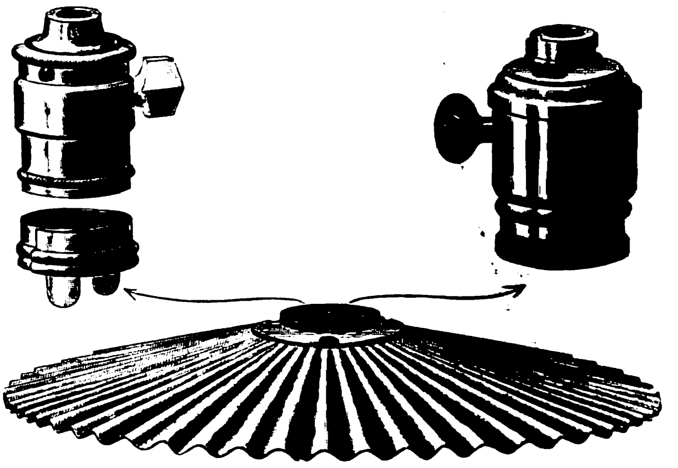
Incandescent plants: Quincy, Ill., 1,300; Monroe, Wis., 1,300; Moosie, Pa., 300; Morristown, Tenn., 650; White River Junction, Vt., 650; Arkadelphia, Kan., 650; Olathe, Kan., 650; Pella, Ia., 650; Waterville, Conn., 1,300; Babylon, L. I., 650; Clinton, Mo., 500; Boston, Mass., 650; Chelsea, Mass., 1,300; Harrison, O., 650; Huntington, Ind., 650; Port Huron, Mich., 1,300; Tuscola, Ill., 500; Worcester, Mass., 1,950; Pawpaw, Mich., 300; Edinburg, Ill., 300; Bennington, Vt., 1,300; Omaha, Neb., 1,300; New Albany, N. Y. 650; Greenville, Mich., 650; Virginia City, Nev., 650; Farmville, Va., 300; Mt. Vernon, N. Y., 1,300; West Superior, Wis., 1,300; Charleston, W. Va., 1,300.

Isolated plants, arc: Schlitz Brewing Co., Chicago, Ill., 6; Alger, Smith & Co., Black River, Mich., 30; J. P. Craig, Memphis, Mo., 30; Glenwood Co., Yonkers, N. Y., 9; Sanderson & Sons, New York, N. Y., 30; Central Iron Works, Harrisburg, Pa., 50; Bradner, Smith & Co., Chicago, Ill., 20; Woodcock & Loring, Chicago, Ill., 12; D. B. Fiske & Co., Chicago, Ill., 35.

Isolated plants, incandescent: Warden Apartment House, Philadelphia, Pa., 1,600; Tuscaroras Advertising Co., Coshockton, O., 100; Backus Wire Nail Co., Cleveland, O., 400; Read House, Chattanooga, Tenn., 600; Hotel Oglethorpe, Brunswick, Ga., 150; Deloach Mill Manufacturing Co., Atlanta, Ga., 100; Nat. Distilling Co., Milwaukee, Wis., 100; St, Louis Railway Co., St. Louis, Mo., 200; A. Zeese, Chicago, Ill., 100; Lane Bros., Newark, O. 150; C. E. Harwood, Lynn, Mass., 150; G. A. Robertson & Co., Hinsdale, N. H., 50; Brooks Bank Note and Lith. Co., Boston, Mass., 100; Orr & Strettle, Piqua, O., 600; Piedmont Bath and Power Co., Oakland, Cal., 500; Fitchburg, Mass., Mfg. Co., 200; Calumet Distilling Co., New Chicago, Ill., 450; H. C. F. Koch, New York, N. Y., 1,200: New York Jockey Club, New York, N. Y., 800; Liss & Rickerman, Chicago. Ill., 100; D. B. Fiske & Co., Chicago, Ill., 250; Walter Aiken, Franklin Falls, N. Y., 100; Clark's Hotel, Boston, Mass., 150; Monmouth Park Hotel, Little Silver Station, N. Y., 800; Wm. Ruehl Brewing Co., Chicago, Ill., 200; E. Richards & Son, Sandy Hill, N. Y., 100; Jordan & Stewart, Oldtown, Me., 50; Newmarket, N. H., Mfg. Co., 400; E. P. Parksons & Co., Tilton, N. H., 200; American Scotch Iron Co., Syracuse, N. Y., 50; E. Frank Lewis, Lawrence, Mass., 100; American Tin & Lead Co., Canon City, Col., 200; Fairchild Paper Co., E. Pepperell, Mass., 200; Gouverneur, N. Y., Wood Pulp Mfg. Co. 50; Lockport, N. Y., Pulp Co., 200; No. New York Marble Co., Gouverneur, N. Y., 50; Allen Bros. & Co., Sandy Hill, N. Y., 400; Walter M. Lowney, Boston, Mass., 200: Clarendon Hotel, Brooklyn, N. Y., 400.

AN IMPROVED INCANDESCENT REFLECTOR.

THE accompanying illustration represents a reflector just brought out by the Electrical Supply Co., of Chicago. It is of tin, bright inside and green without, after the usual fashion, its novelty lying in the method of its application to the lamp. As will be seen, there are no screws, no springs and no clamps. It is attached directly to the lamp socket without the use of a shade holder. Instead of all these, a small clip is used for fastening to the sockets, which have no special holding arrangement. Taken altogether, the new reflector is extremely simple and serviceable.


IMPROVED INCANDESCENT REFLECTOR.

THE CRESCENT INSULATED WIRE & CABLE CO.

The above company have entered the field with the determination of securing a large share of the insulated wire business. Their wires are all covered in such a way as to be entirely seamless on either side. "We not only use," they say, "the highest grade of Lake Superior copper and of 'Old Para' rubber, but our manner of treating the caoutchouc in our compounds is such as to secure the highest degree of insulation resistance." The factory and main offices are at Trenton, N. J. Mr. C. Edward Murray is the president of the company, Mr. Richard R. Whitehead, vice-president and treasurer, and Mr. Harry T. Solliday, secretary, while Mr. Thomas S. Reed is the superintendent and electrician. The company have prepared and printed a price list of their various styles of wire.

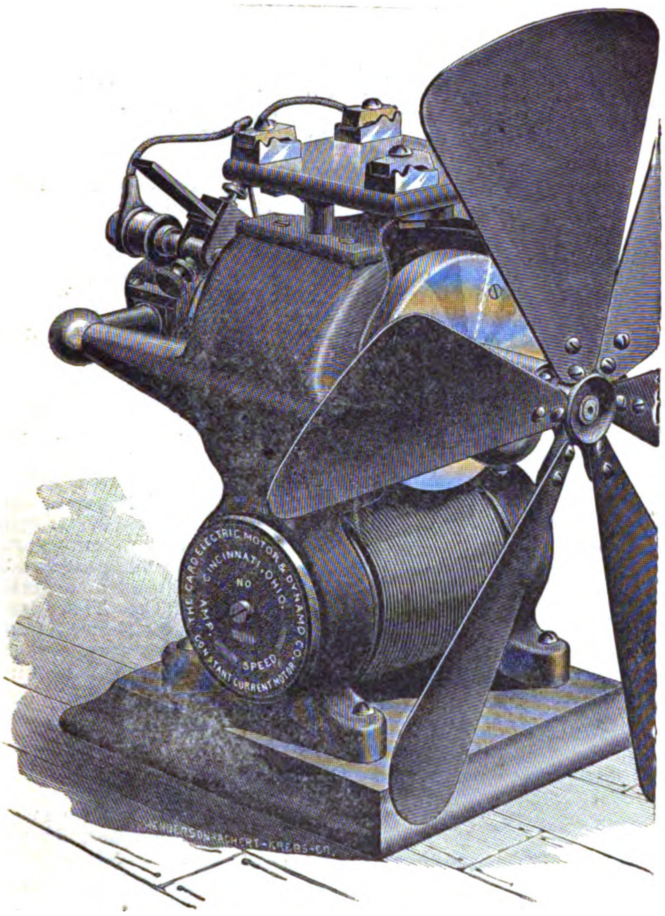
OMAHA, NEB.

An electrical engineering company has been formed by B. D. Kennedy, R. B. Howell, J. P. Allen and H. E. Chubbeck with a capital stock of $25,000. The company will construct, operate and repair electric circuits and do other work of an electrical nature

THE CARD FAN MOTOR.

It is appropriate at this time, when it is beginning to become evident that summer will soon be upon us, to bring to the notice of our readers anything that tends to lessen the burden of life during that trying season. In this connection we may mention a new fan motor, having several points of interest and merit, that has recently been brought out by the Card Electric Motor and Dynamo Co., of Cincinnati. It is very compact, and of exceedingly simple construction. The commutator is of large size, which makes it exceedingly durable, and the machine will give the full rated power, and even exceed it, if necessary, without burning out. This is an important point, as there is a general tendency to overload small motors.

As will be seen in the accompanying illustration, a single field coil is used, and the motor is fitted with self-oiling bearings requiring a minimum of attention. It is built in two sizes, ⅛ and ¼ h. p., and as carefully constructed as a large machine. It is efficient in operation, durable, and thoroughly reliable.



CARD FAN MOTOR.

NEW ISOLATED PLANT OF THE PACIFIC ELECTRICAL STORAGE CO.

In order to meet the demand for small incandescent light plants, the Pacific Electrical Storage Co., of San Francisco, Cal., has designed an installation which renders the consumer independent of outside institutions, and gives light comparing favorably with gas as to cost of maintenance. It consists of a 1 h. p. gas engine, 11 cells of "15-M" type accumulators, a switch-board, a shunt wound dynamo having a normal output of 16 amperes and 30 volts, and 20 16-candle power lamps and key-sockets.

No difficulty is experienced in setting the engine and dynamo, the latter of which requires a floor space of about 24 by 12 inches, and full instructions are furnished for wiring. The battery is entirely automatic, and 99 per cent. of the lights may be turned off at once without in the least affecting the other lamps or the working load of the dynamo, and hence but little attention is required.

By running the dynamo five hours a day, enough current can be generated to supply 30 lamp-hours per day. If for two hours in the evening it should be required to run the dynamo to supply an additional 8 lamps, this would make a daily consumption of 46 lamp hours, and a run of 7 hours for the engine, which burns not more than 30 cubic feet of gas per h. p hour. Gasoline instead of gas may be used as fuel if desired.

The company also furnishes plants of larger capacity when required.

By the placing of storage batteries as an adjunct to the incandescent plant, the lighting capacity can be doubled; or, if it is desired to install an incandescent plant of a given number of lights, it is only necessary to install a dynamo and engine that will be able to carry half the total number of lights during the hours of maximum load, the storage battery furnishing the current for the remaining half, and receiving its charge during the hours of light load. This system, commonly known as the "half and half" system, reduces the first cost of the steam and dynamo plant by nearly one-half, a very important item.

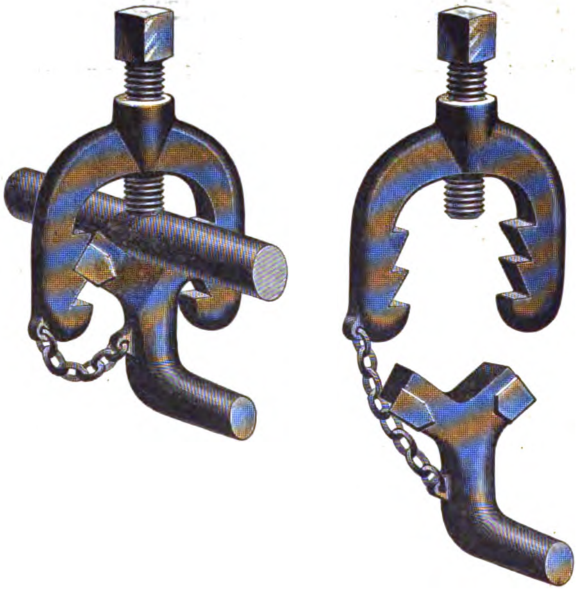
THE SAMSON CORDAGE WORKS.

The Samson Cordage Works, of Boston, have been sending to electric light companies and supply houses, sample cards showing their solid braided cordage for suspending arc lights, street car trolley cord, and for covering the magnets of dynamos. This cord has been used for such purposes by a few for a number of years, and now that the manufacturers have taken steps to make the goods generally known they find a very gratifying increase in trade.

A NOVEL LATHE DOG.

THERE has always been more or less annoyance, inconvenience and loss of time in machine shops, from the fact that lathe dogs must be adjusted to the work before centering it in the lathe.

The accompanying illustrations show a dog manufactured by The Indispensable Lathe Dog Co., of 1209 Buttonwood St., Philadelphia, which overcomes this objection. It can be attached to work after the work is centered in the lathe, and can be used as well between collars as upon plain or straight work. A large dog can be used on a light mandrel where the work is large in circumference. It can also be used for locking work on the mandrel to prevent slipping. These dogs are drop forged from bar steel, and fitted with steel set screws. They are made in four sizes, the smallest taking from ¼ to 1 inch, and the largest, from 1 to 3¼ inches.



THE "INDISPENSABLE" LATHE DOG.

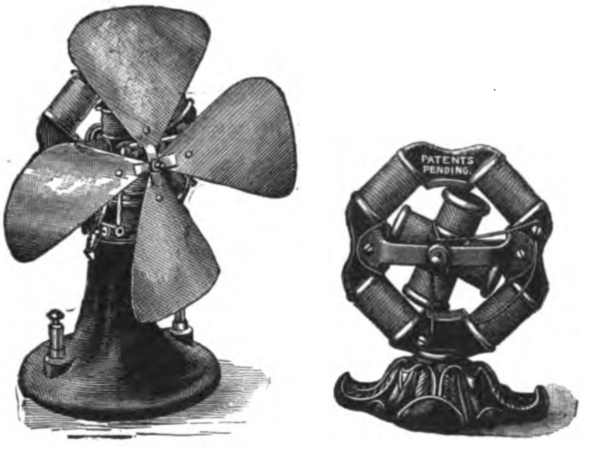
THE CENTRAL ELECTRIC COMPANY are making a special drive on hard rubber goods, offering the celebrated products of The Butler Hard Rubber Company, New York, at prices lower than ever, and making prompt shipments, which is telling with the trade and consumers. They are introducing a compound that takes a good finish, and is specially recommended for its insulating qualities. As the sole Western agent for the Paiste Edison Key Socket, the Central Electric Company have already had numerous large orders for this latest improved socket, which is virtually a 5 ampere Paiste switch mounted in a handsomely finished shell.

PACIFIC TELEPHONE ATTACHMENT & RECORD CO.

The above company, of 206 California street, San Francisco, are introducing a simple device which can be readily attached to any telephone, whereby the handle of the magneto is completely covered by a case or door. Into a slot in this door one can drop a coin, whereupon the door will open; and until the door is opened the telephone can not be used. The coin drops into a receptacle to which the owner of the attachment alone has a key and lock. The attachment is so regulated that the door will open with either a nickel, dime or quarter, as may be desired. As a cure for dead-head telephoning the device seems to possess many notable recommendations.

E. S. RITCHIE & SONS' MOTORS.

We illustrate herewith two small motors, the design of Mr. W. B. Luce, which have recently been brought out by E. S. Ritchie & Co., of Brookline, Mass. They are of various sizes, from that which will run a toy or a small fan up to those capable of driving a sewing machine, dental and other small lathe, and the like. They are very handy for lecture illustrations and minor experiments requiring power. The firm will also supply castings, finished or unfinished, for small motors, so that the student or beginner may do a little experimenting in motor design and construction on his own behalf. It may be mentioned that the house supply hand-dynamo machines, which will furnish a current capable of good work.



Ritchie & Sons' Motors.

CINCINNATI TRADE NOTES.

The Electric Supply and Contracting Co., Nevada Building, Cincinnati, O., are doing a large business in various kinds of electrical apparatus and supplies. They are agents for the well-known C. & C. motors, a large number of which they are installing. They also pay attention to repair work, rewinding armatures, etc., and wiring of buildings for arc or incandescent lighting, and electrical and mechanical engineering work of all kinds. Mr. F. E. Perry, widely known in electrical circles from his long connection with the Edison Co., is the manager of the company, and associated with him are Mr. Geo. C. Kuntz and Mr. S. I. Crain.

The Triumph Engine Co., Cincinnati, are kept busy filling the demand for their compound engines, which are giving universal satisfaction wherever installed. Their engines are noted for their economy and simplicity, and are remarkably durable and reliable.

The Boughen Engineering Co., 179 Race street, Cincinnati, engineers and contractors, have several large jobs in power plants for electrical work on hand, and are figuring on numerous others. They make a specialty of this class of work and have installed some very fine plants, which are giving excellent satisfaction. In addition to electrical work they have several large complete steam plants under way.

The Lane & Bodley Co., Cincinnati, O., the well-known builders of improved Corliss engines are turning out a large number of these engines of various sizes and large quantities of other machinery for power plants of all kinds. They are furnishing all the engines for the Hunt street power house for the electric street railway plant. Steam is supplied from a battery of boilers of 1,000 h. p., with Murphy furnaces, and 14 miles of road with 20 motor cars and 20 trailers are in operation. The plant will shortly be increased. Mr. Philip King has charge of the road and Messrs. J. E. Ginter and Jas. Taylor are the engineers and look after the running of the plant.

The Colerain Avenue Electric Railway Plant.—This street railway plant is one of the best equipped in the country. The Thomson-Houston system is used. It is a double trolley wire road, thereby obviating any trouble to telephone wires by induction currents. The present plant comprises eight 80,000 watt Thomson-Houston generators driven by one Hamilton-Corliss engine of 400 h. p. and 2 Ball engines of 250 h. p. each. A Buckeye engine of 30 h. p. is used for running a separate generator for lighting purposes.

Thomas J. Creaghead, consulting and constructing electrical engineer, with offices in the Mitchell Building, Cincinnati, O., is doing a very good business in territory around Cincinnati. He is handling some of the latest specialties in the electrical supply line and is prepared to put in any kind of an electric plant, from a fan motor to an electric railway.

NEW YORK TRADE NOTES.

The Shaver Corporation, of 207 Broadway, this city, report business as very brisk for their acoustic telephones. They have a complete telephone outfit, and its adoption in several prominent cities of the country has served to demonstrate its efficiency in every way.

Page Belting Co.—Since this company have opened their New York store at 16 Dey street, with Mr. Geo. A. Pierce as manager, business has been coming along very nicely. The "Acme" link leather belt manufactured by this firm runs without slip, and with minimum strain upon the journals and bearings. For those who have tried linked belts and do not feel satisfied with the manner in which they have worked, a visit to Mr. Pierce will perhaps prove of interest and value. They also make all kind of belts for electric light purposes.

Mr. M. J. Sullivan, has been transferred from the legal department of the Edison Electric Light Co., to the intelligence department of the Edison General Electric Co., with headquarters at the Edison building, 44 Broad street.

Asa W. Hall, once connected with the Ball Electric Light Co., of this city, is now, and has been for the last eighteen months, electrician for the National and Providence Worsted Mills, Providence, R. I. This is one of the largest isolated manufacturing plants in that State, and is made up of 1,600 incandescent and 350 arc lights. The incandescents are of the Edison and Mather systems, the arc lighting being done by the Ball Co. There are 14 arc machines in use. A recent visit to this plant showed that a great deal of pains was being taken with the apparatus, and Mr. Hall is to be congratulated upon the success of the plant under his charge.

Innis & Co., of 120 William street, this city, are importers of a superior grade of sal ammoniac for battery purposes, and on orders of large quantities can quote some good prices.

C. S. Van Nuis, of 74 Cortlandt street, this city, is having quite a run with the "Ajax" switches. He also designs slate switch-boards on which he uses some of his patented novelties, the result being a switch-board it would take hard work to excel.

Edward Cliff, late chief lineman for the Richmond Light, Heat & Power Co., Staten Island, has invented and patented the "Cliff Mast-Arm" which is used by that company. It is being placed on the market for general adoption by W. H. Kinlock, of New Brighton, S. I.

The Palermo Mica Co., of 27 Peck Slip, this city, are dealers in mica for all purposes. The amount of mica which this company furnishes for the electrical industry is something enormous. Mr. Melville Seabury is sales manager.

Belding Bros., of 455 and 457 Broadway, this city, silk manufacturers, are making the finest silk for electrical purposes. They have large mills both in Rockville, Ct., and Northampton, Mass. Mr. C. W. Darling presides over the interests of the New York store.

The Crowdus Chemical Electric Co.—There are doubtless a number of our readers who will welcome in the electrical field, as wholesale dealers in supplies, the Crowdus Chemical Electric Company, of Memphis, Tenn. This company has secured a handsome five-story building, having floor space of 25 x 150 feet, situated on the principal business street.

They have equipped, the top floors with machinery for the manufacture of their Crowdus battery, and specialties, and will devote the remaining floors to supplies, having already secured the agency for several leading staples. They will carry a stock of electric fixtures and have for this a room wired with fifty outlets, in which are displayed the many beautiful effects of handsome electroliers and bulbs.

Their building is lighted with arc and incandescent lamps, the current for them being taken from their remarkable Crowdus batteries. Mr. Crowdus announces that they have received, without asking, as many orders for batteries as they can fill until their new factory is entirely equipped.

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RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.—I.

BY

Carl Hering

IN the ideal system of wiring for incandescent lamps (or motors) in multiple arc, there are two requirements, assuming that the potential is kept constant at the source: *First*, that each lamp should have the same potential at its socket, as all the other lamps, when all are burning at once; *secondly*, that this potential should remain constant at each lamp, when the other lamps are turned off. In some cases, as for factories, street lights, store lights, etc., only the first requirement need be complied with; in other cases, as in dwellings, theatres, etc., both conditions must be provided for. The second condition is the one most difficult to provide for, and it necessarily includes the first. A number of systems of running the leads will comply with the first condition, but to meet the second condition there is only one ideal system.

In general, it would be quite impracticable to comply strictly with either of these conditions, and therefore a slight margin of variation at the different lamps is usually allowed; the amount of such allowable variation, being necessarily different for different conditions, must be chosen by the judgment of the engineer. This variation is due to the different losses in potential in the leads to the different lamps. This variation is therefore not identical with the loss in the leads, but it is the differences between these losses when the losses are not precisely the same to all lamps.

The amount of wire used increases very rapidly as the allowable loss is diminished; for a 1 per cent. loss, for instance, the amount of wire by weight is double what it would be for a 2 per cent. loss. On the other hand, if the lamps must be capable of being turned off one by one, the life of the lamps in the general systems diminishes rapidly as this allowable loss is increased, because the unavoidable differences between the losses to different lamps, that is, the variation, increases. It is therefore a choice between two evils. As the conditions are quite different in the case when the lamps may be turned off one by one, from that in which they always burn together, the two cases must be considered separately and should not be confounded with each other; the former, of course, includes the latter, and is therefore merely an additional condition to the latter.

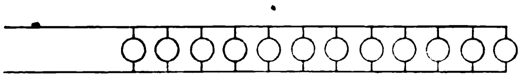


FIG. 1.

The case in which all the lamps are either burning, or turned off together, is by far the simpler of the two. In the simple case shown in Fig. 1, the difference between the potential at the nearest lamp and that at the farthest, is merely the amount lost in the length of wire between the two lamps, and it is entirely independent of the amount lost between the dynamo (or centre of distribution) and the first lamp; this latter loss, may, therefore, be made as great as desired, as far as the lamps are concerned. In this case, therefore, the loss from the dynamo to the first lamp may be made anything that is desired, but the wire between the first and last lamp must be so large that the loss on that portion does not exceed the allowable variation for the lamps, say, about 1 per cent or at most, 2 per cent. If this portion of the circuit is so long that it would require a very large wire, then the lamps are often divided into two or more groups, as shown in Fig. 2, each group being supplied or fed by a separate set of leads; these two separate sets of leads must then be calculated for the same loss as before between the dynamo and the lamps, thus requiring the longer ones to be much thicker than the shorter ones, as shown. The choice between the dispositions shown in Figs. 1 and 2, depends entirely on whether the wire between the first and the last lamp must be so thick, owing to the allowable difference between the lamps, that it would be cheaper to divide the leads to dynamo into two parts; this can be determined only by calculating both cases. In Fig. 1 it might, under special circumstances, be quite rational to connect the lamps by a much thicker wire than that leading to the dynamo, even though the latter carries a greater current. The disposition shown in Fig. 2, of running separate sets of leads to different groups of lamps, applies equally well to groups of lamps in different directions from the centre of distribution, and in this sense it is one of the most frequent and best systems of distribution.

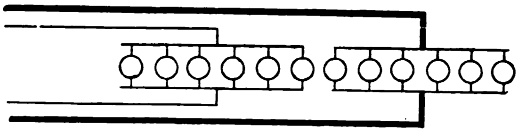


FIG. 2.

Another system, but applicable only in special cases, is that shown in Fig. 3, in which the two leads from the dynamo divide, one going in one direction around a rectangle, and the other going in the reverse direction. No matter what the loss or the size of the wire, all the lamps between this pair of leads, will have the same potential, provided the positive and negative leads are both of the same size, and provided all the lamps are turned on and off together; if the lamps are turned off one by one, the potential will no longer be constant.

To recapitulate, it will be seen, that when the lamps of a group are all turned on or off together and not individually, the distribution is simple, requiring only, that the *difference* between the potential at the nearest and the farthest lamp on the same leads shall not exceed the allowable variation of 1, 2 or even 3 per cent. (in which case the lamps are entirely independent of the loss between them and the dynamo or centre of distribution), and that if there are a number of such groups connected to the same dynamo or centre, the loss from dynamo to lamp must be the same for each group. In the latter case the groups will be entirely independent of each other, and may be turned off or on as individual groups, provided their leads do not join those of any other group on their way to the dynamo. In other words, groups having independent connections to the dynamo, are independent of each other, and may be turned off or on as groups. It is assumed, of course, that the dynamo is self-regulating.

Taking up the other case, in which the individual lamps are to be turned off and on, the problem is quite a different one. Referring again to Fig. 1, the loss of potential from each lamp to the dynamo or source depends on the total current in the common leads and on the resistance of these leads; these losses therefore remain constant only as long as the total current is constant; if one lamp is turned off, the total current becomes less and therefore the loss to each remaining lamp becomes less, and *vice versa.* Finally, if all but one of the many lamps are turned off, the loss in the leads will be very small, and, therefore, the potential at the last remaining lamp will be increased accordingly. Each individual lamp is therefore dependent not only on the others, but also on the total loss of potential between it and the dynamo. It is in the latter feature that this case differs entirely from the first case described above, in which they are all turned off or on together. For independent lights the loss between them and the dynamo must therefore be made as small as practicable, as it affects the steadiness and life of the lamps. For this reason it requires, in general, relatively thicker wire for independent lamps than for groups, provided the distance to the dynamo is sufficiently great to make a difference.

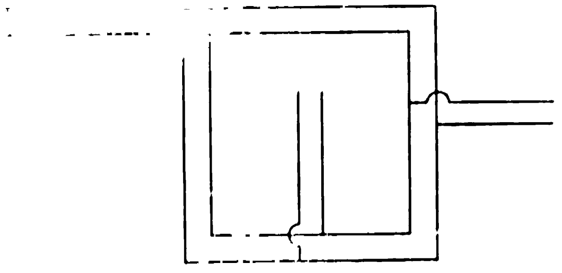


FIG. 3.

Suppose, in Fig. 1, there are 100 lamps and the loss from the dynamo to the first lamp is four volts when all are burning; then if all but one are turned off, the voltage of that one will be about four volts in excess of what it should be. In order to save the lamps from part of this strain, the voltage of the dynamo may be so chosen that when all are burning they will be two volts below the normal, and when only one is burning it will be two volts above, the difference remaining, as before, four volts. If, as in a dwelling, the full number of lights burning is the exception, and a few lights, the rule, then the potential at the dynamos may be chosen so that it is the proper amount at the lamps when the average number is turned on.

As the potential at the lamp depends on the total current in the leads, it follows that the ideally perfect system of independent lamps is, to have a separate pair of leads for each lamp back to the dynamo (or centre of distribution). Each pair of leads is then calculated so as to have the required loss for its lamp. Such an ideal system is, however, not practicable as a rule, but the general rule may be laid down, that the nearer a system approaches to this ideal, the better it is. For instance, comparing Figs. 1 and 2, in each of which there are twelve lamps, the second approaches more nearly to the perfect system, and the lamps in Fig. 2 are subjected to only *half* as great a variation in potential as those in Fig. 1, when all but one are turned off. It follows from this rule that the distribution is better, the more a circuit is branched, the nearer such branch connections are to the dynamo, and the larger the number of independent leads to the dynamo. Such distribution is better, not only because the lamps are subjected to less variation of potential, but for the same allowable variation of, say, 2 per cent. at the lamp, the total loss from the dynamo to the lamps may be chosen much greater than in other systems thereby saving wire, for it is evident that in the ideal system the loss from the dynamo to the lamps may be made anything desired, without making the lamps dependent on each other. Their dependence on each other varies with, and is proportional to, the number of lamps on one wire, and the distance from the dynamo to the junction of their individual wires.

It is sometimes thought that the ideal system may be carried out by calculating the leads to each lamp or group of lamps separately and then bunching all the wires running parallel, into one common wire having a cross section equal to the sum of all the smaller wires combined. But this is an error, and may result in a worse distribution than if it had been calculated on the usual plan. As soon as two wires are metallically connected, they become one and the same wire from there to the dynamo.

To recapitulate: When the lamps are to be cut off independently, they are dependent on each other and on the loss of potential between them and the dynamo, *in so far as they are connected to common leads.* The leads should therefore be split up as much as practicable and the total loss should be divided so as to have the greater part in the small individual branch wires, and the smaller part in the larger main wires.

ON THE DESIGN OF ALTERNATING CURRENT MOTORS.

BY

A. H. Weston.

A SERIES of experiments and investigations, conducted for some time past by myself, leads me to believe that the alternating current is as applicable to the purposes of power as the constant current, but that certain definite conditions must be observed in the design of alternating current motors which do not come into consideration at all in a constant current motor. It is true, I have, so far, experimented only with small motors, but I believe that large self-regulating motors can be constructed according to the same principles, to operate successfully.

In dealing with the alternating current, one of the most important things to be considered is the self-induction which the current tends to set up, producing an E. M. F. contrary and inimical to its own E. M. F. This self-induction, which is the attribute of the dynamic nature of the alternating current, always acts to destroy or neutralize the current which sets it up. In exactly the same manner does the expansion of steam, or other vapor, whose force of expansion is due to heat, and by means of which expansion it does its work, consume or neutralize the heat which produces the force.

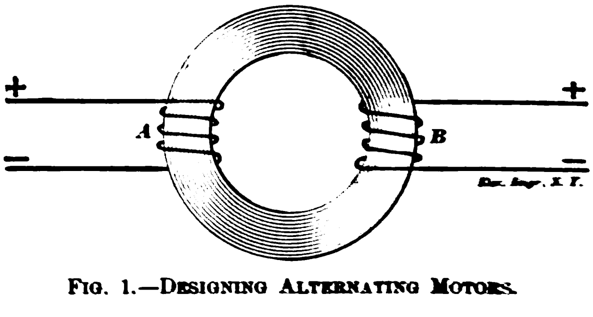


FIG. 1.—DESIGNING ALTERNATING MOTORS.

Now in making an alternating current motor it is necessary to dispose the windings on the magnetic circuit so that the value of the self-induction will vary as nearly as possible inversely as the work done by the motor. I believe that this condition can be approximated, if not exactly attained, by having due regard to the magnetizing and mutual inductive effects of the windings on the armature and field.

Let us consider the behavior of two similar coils of equal magnetizing effect, wound upon a simple magnetic circuit. Fig. 1 shows such an arrangement. In all cases we will assume that the magnetic circuit is thoroughly laminated in the direction of the lines of force, as that is, of course, always necessary.

If an alternating current is caused to flow through the coil A having at any instant the polarity indicated, there will appear in the coil B, if the circuit of the same is completed, a current of opposite polarity, as indicated, which will vary with the resistance of the circuit. If the coil B remains open so that the resistance through its circuit is infinite, the self-induction produced by the current in the coil A will react against the said current, and, if the inductive properties of the iron were perfect, would cause a counter E. M. F. equal to the original E. M. F. producing the current and check it altogether. This is, in general, the action of the converter.

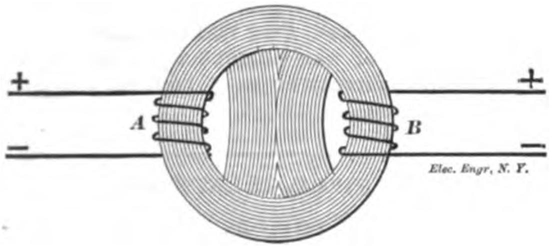


FIG. 2.—DESIGNING ALTERNATING MOTORS.

If we impress upon the coil B an E. M. F. similar to the E. M. F. producing the current in A but reversed in direction to that shown in Fig. 1, we will experience the same result as in our last experiment, only *more so*, so to speak. If, on the other hand, we cause the same alternating current or similar currents to pass through each coil in the direction indicated in Fig. 1, it will not only be found that the self-induction will be entirely eliminated, but if the E. M. F. is maintained the same at the terminals of each coil, the current flowing through each will be proportional to the sum of the two E. M. F's.

Let us now divide the magnetic circuit of the iron ring by establishing a magnetic path across the ring, as shown in Fig. 2, and cause the current to pass through the coils in the direction shown. What will be the result? We will now find the self-induction present in full force, as in the case of the transformer with an infinite resistance in the secondary circuit. Both coils now co-operate to project the lines of force across the centre path in the same direction. This is the condition which would exist if we were to consider the ring as a motor field and place an inert armature within the ring.

If we now consider the nature of an armature apart from its field, such as the ordinary form of Siemens drum armature or Gramme ring, we will readily see that, supplied with current from two brushes set at diametrically opposite points of a commutator, it can be considered for the purposes of this discussion as similar to the system shown in Fig. 1, but better shown in Fig. 3. That is to say, apart from the field, in a non magnetic medium, such as air, an alternating current will encounter no impedance in passing through the windings, save that due to one-quarter of the whole ohmic resistance of the coils. If, however, we place it in an inert field, as shown in Fig. 4, we provide a magnetic path from one side of the system to the other, producing the same condition in the armature as we have in the field in Fig. 2, only that the path is external, instead of internal. In this case the magnetizing effect of the armature coils tends to project the lines of force across this external path in the same direction, and this produces self-induction in the armature coil which checks the current, as in the last case considered, of the field.

Fig. 4, it will be seen, is perfectly analagous to Fig. 2, excepting that in Fig. 4 we have the means of causing magnetic energy in the centre path, *per se* inert in Fig. 2. We will now cause an alternating current to pass through the field coils in the direction shown in Fig. 4 and a like current to pass through the armature coils so that the magnetic forces of all the coils tend to project the lines of force through the armature path in the same direction. The self-induction will now attain its maximum value in all of the coils and the system, so arranged, will be practically opaque to the passage of current, as in the third case considered in connection with Fig. 1. In this condition the armature will have no tendency to revolve, as the magnetic current defined by the magnetizing forces of the field and armature coils will be the shortest circuit possible through the system and the forces between the field and armature will be in equilibrium. The points of contact of the brushes with the commutator will now coincide with the polar line C D of the field and armature. This, theoretically, will be the condition under which a perfect motor will work with no load. By this, I do not mean that the brushes would necessarily be at this point. They might, or might not, be.

The last to be considered is the case wherein the magnetizing force of the armature is reversed, which can be accomplished by swinging the brushes, as last connected, through an arc of 180°, where they will again coincide with the polar line of the system. Here we have the magnetizing forces of the field and armature coils tending to project lines of force around the circuit in opposite directions and we will have in all of the coils the same condition as we had in the armature coils apart from a field, or in the field coils apart from an armature, in the last case considered in connection with Fig. 1. In this position an excessive current will pass through the coils and the armature and field will be in a condition of neutral instability. The slightest displacement of the armature in either direction will give it tendency to move in that direction. In popular language, it would move by repulsion.

It will now be readily understood that there will be a position of the brushes between these extreme positions where the resultant opposing magnetic force of the armature will create a "reluctance" in the armature portion of the magnetic circuit, less than the reluctance which would result from the removal of the armature altogether, leaving only an air space, and greater than the reluctance of an inert magnetic path, such that the self-induction of the coil would just be eliminated.

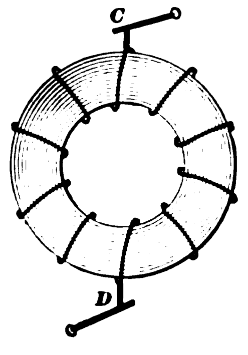


FIG 3.—DESIGNING ALTERNATING MOTORS.

This is, theoretically speaking, the desired condition, although practical considerations of regulation might dictate some departure from this. By making the magnetic force of the armature coils of sufficient magnitude, this condition can be attained at the point where the brushes will give the most effective torque to the armature. With the armature clamped in this position the current will experience only the ohmic resistance of the coils and the motor will take its maximum current, which will produce a powerful directive tendency in the armature to revolve.

The acceleration of the armature in its attempt to reestablish equilibrium will cause a diminution of the opposing force exerted by the armature coils, which causes a rise in the self-induction and counter E. M. F. in the coils, and by a proper utilization of this property the motor will be self-regulating for speed under varying conditions.

Now a word about the relative magnetizing forces of the field and armature coils. We know it is the practice in constant current motors to make the magnetizing force of the field greatly preponderate over that of the armature and the armature core takes its resultant magnetic complexion from the field. It can readily be seen that this will not do at all for an alternating current motor, as the armature must be able to outweigh the field in magnetizing power. As a rough approximation, we will say that the effective magnetizing force of the armature coil must be equal to that of the field coils. As the effective magnetizing force of the armature coils is not the whole magnetizing force represented by the ampere turns of its coils we must make due allowance therefor.

The relation which the effective magnetizing force bears to the magnetizing force is as follows :—

Let M = the total magnetizing force of the armature turns, and m, the effective force. Then $\frac{m}{M} = E$; E being the average value of sin β between 0° and 90°.

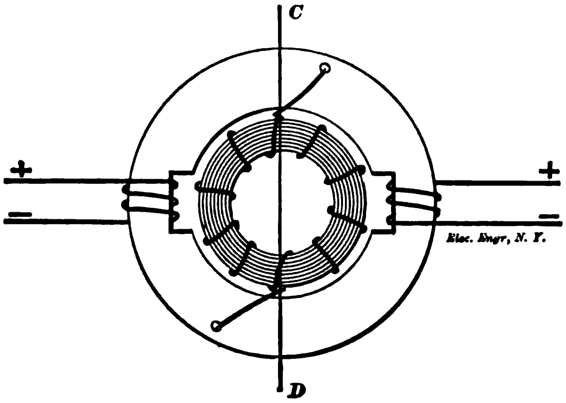


FIG. 4.—DESIGNING ALTERNATING MOTORS.

As $E = \frac{2}{\pi}$, if we find that the magnetizing force of the armature must be n times that of the field, letting N represent the number of ampere turns on the field, and C the number of ampere turns on the armature, it follows that

$$C = \frac{\pi N n}{2},$$

which will give us the required effective magnetizing force in the armature.

In designing the field of an alternating current motor it will readily be seen from the above that the coils must be so disposed upon it as to counteract their self-induction when the proper degree of "reluctance," or permeability, is produced in the armature portion of the magnetic circuit. That is to say, the field should form a divided circuit in connection with the armature, the coil turns being equally distributed on each division. It would be perfectly possible to embody the above principle in a multipolar motor and armature, and I have selected the bi-polar type for illustration only as being less complex in its nature.

The type of field which I consider best adapted for alternating current motors is the simple ring circuit shown in Figs. 1, 2 and 4. Of course, other modifications may be used which would answer practically as well, but this seems to me to be the simplest and most ideal form.

Rotation of the armature can also be secured by short circuiting the two brushes instead of causing a current to flow through the armature coils. The current in the armature coils will then arise from the inductive influence of the field and the proper "reluctance" may be produced by swinging the brushes around to the proper position relative with the field, which will change the direction of the magnetizing effect of the armature coils.

I have watched with much interest the labors of several able experimenters in the direction of designing a motor without the usual form of commutator for the revolving element. While there is no doubt that such a motor is a thing greatly to be desired, I have come to the conclusion, after a careful analysis of the whole subject, that with a current of only one phase, that is to say, without transforming the phase of the current by some means, we must accept the commutator as a necessary function of continuous revolution.

THE FIELD TELEPHONE.

In the usual forms of receiving telephones it has been the practice to polarize the core and diaphragm to the utmost possible extent. A novel form of telephone has, however, been recently devised by Mr. Stephen D. Field, of Stockbridge, Mass., which is both a receiver and transmitter, and in which the inventor proceeds in a directly opposite manner, aiming to have these parts as neutral as possible, though at the same time making use of a magnet of great strength.

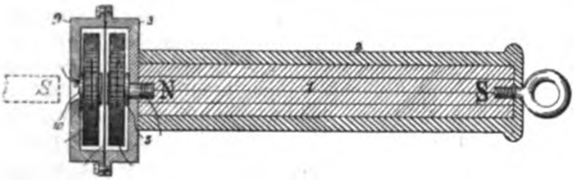
This instrument, shown in the accompanying illustration, is of the polarized type in which the permanent magnet constitutes a practically closed magnetic circuit, and has an open electro-magnetic circuit in which the diaphragm is situated. These two magnetic circuits are so arranged relatively to each other that the currents flowing around the poles of the open electro-magnetic circuit will cause more or fewer lines of force to be deflected from the closed or practically closed magnetic circuit, owing to the peculiar reactionary effect of the currents in the coils of the electro-magnets.

The action will be understood from the engraving, in which 1 represents a permanent magnet, made up of a number of separately magnetized steel bars. At the N-pole of this magnet is placed a cylindrical iron armature 3, attached to the magnet system by the core 5, whose projecting end is screwed into the magnet and on which is mounted a helix, as shown. Across the face of the box armature is placed the diaphragm, which is held in position by the cover of the box. This cover carries on its inner face a projecting tubular core, on which is mounted another helix. The current flows in opposite directions in these two helices, as indicated by the arrows.

By this construction, two paths are opened for the lines of force from the magnet pole N ; one, by way of the walls of the case, with which the diaphragm is in direct contact, and the other, by way of the cores 5 and 10. The latter path is broken by the space between these cores and in this space the diaphragm vibrates. So far as concerns the cores, but very little polarity will normally be found between them in their adjacent ends, since the iron case forms a short circuit or "magnetic shunt" around them, and consequently the diaphragm will not be attracted toward one any more than toward the other by the mere influence of the permanent magnet.

Considering now that current-impulses are passing through the coils, the action will be as follows : We will suppose that the current flows in the coil on the right of the diaphragm in such direction that it tends to induce S-polarity at the front end of core 5. Then a similar polarity will be developed in the front end of core 10. The lines of force will tend to circulate through the two magnetic circuits formed by the diaphragm and the sides of the iron box. Those lines due to the magnetization of core 5 will tend to flow from the end of the core through the box to the diaphragm, and through the diaphragm to and through the air-space between it and the core 5. These lines of force will be opposed in the air-space by the lines flowing through the air-space due to the permanent magnet, but the lines due to the other coil will proceed from the end of the core, to the side of the box, to the diaphragm, to the air-space, and back to the end of the core. These lines will be assisted in the air-space by the lines from the permanent magnet, but will oppose the flow of the latter through the box and the lines from both sources will pass in multiple arc through the diaphragm. The lines of force due to the permanent magnet will therefore follow the path through the box to the diaghragm, through the diaphragm to core 10, and through core 10 to the south pole of the permanent magnet.

It will therefore be seen that one core will be strengthened and the other will be weakened by any given current-impulse which circulates through their surrounding coils, and the diaphragm will, of course, be attracted by the stronger polarity. The amount of this respective weakening and strengthening depends upon the current flowing. The result is a movement of the diaphragm toward one or other of the cores with a force dependent upon the strength of current used, and as the currents in the respective parallel coils flow in opposite directions, their inductive effects largely serve to neutralize their magnetic lag, so that the latter is quite unaffected by the strength of current flowing. In all cases the movement of the diaphragm is exceedingly sharp and prompt whether the current used be very heavy or almost infinitely small.



THE FIELD TELEPHONE.

The action may be perhaps more clearly understood by assuming the presence of a mass of iron, or imagining a phantom pole in front of the mouth-piece, as indicated by the dotted lines.

WICKES' SENSITIVE RELAY.

ALTHOUGH the relay is among the oldest of telegraphic devices it may be said to have undergone practically no change or improvement since its inception. This is more particularly the case with reference to the means of adjustment by which the sensitiveness of the relay can be altered to suit the varying conditions of the line or battery. The present method, consisting in varying the tension of the retractile spring, requires not only some time to effect a correct adjustment, but, besides, gives the operator no indication of the true relation or distance between the armature and the ends of the magnet poles. In other words, there is no way, except by tedious trial, by which a predetermined adjustment can be at once effected and maintained, and the adjustment at the same time made as full as desired.

It is with the object of accomplishing this that Mr. Robert C. Wickes, of New Hamburg, N. Y., has designed the sensitive relay shown in the accompanying engravings.

For this purpose Mr. Wickes employs a pinion A and a gear wheel B, to which is attached a handle C and index hand. An arc shaped slot in the bed plate allows the handle C to move through any angle of a semicircle, which causes the magnet to approach or recede from the armature through a greatly reduced distance, because the pinion A is also a nut gearing with the screw D extending downward from the magnetic yoke. To prevent any lost motion through the action of the several gearings, a helical spring E encircles the screw D and presses permanently upward against the yoke.

It will be evident that if the handle C is moved through the least distance possible by the operator, the motion which is thereby transmitted to the magnet is almost infinitesimal, thereby supplying a very sensitive adjustment. The cross bar F of the armature is pivoted and provided with a spring (not visible) connecting with the small spindle G by a silk thread.

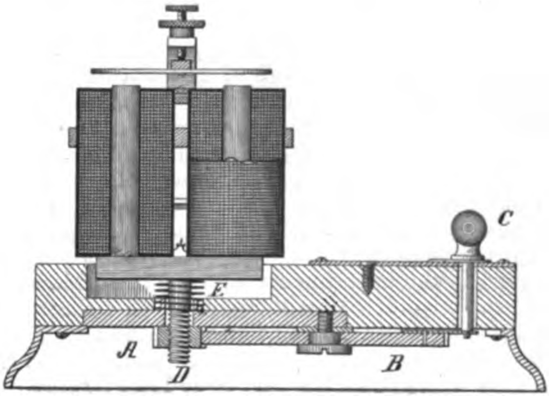


FIG. 1.—WICKES' SENSITIVE RELAY.

By slight modification in the electric connections and with similar advantages, the same construction may be substituted for relays which are common in fire alarm and district telegraph apparatus in which multiple stations are connected with a central station, and in which two local circuits are controlled by the relay armature.

In the ordinary relay, where the thumb screw is employed, the quick and delicate adjustment of the magnet is impossible. With the present construction, however, the handle may be moved throughout the whole semicircle, in the time occupied in turning a thumb screw once.

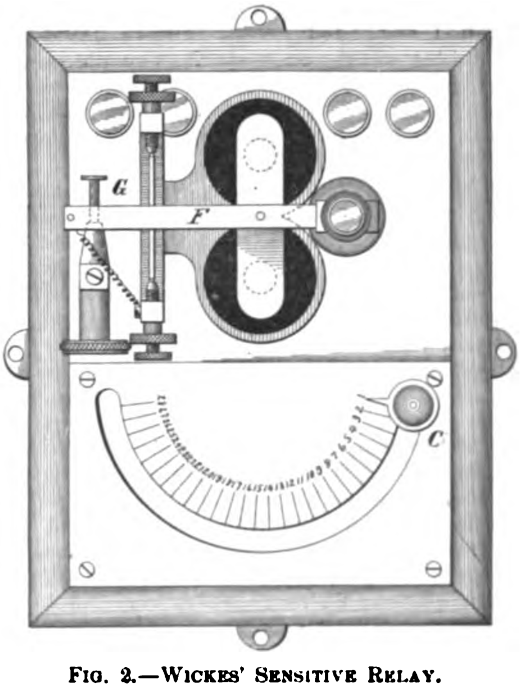


FIG. 2.—WICKES' SENSITIVE RELAY.

ALTERNATING CURRENTS OF HIGH FREQUENCY.—A REPLY TO MR TESLA.

BY

Elihu Thomson

In regard to the comments of Mr. Tesla published in The Electrical Engineer of March 18, concerning my note in your issue of the 11th, I think it desirable that I should make a few remarks. Mr. Tesla appears to infer that my investigations of the properties of alternating currents of high periods must have been subsequent to the note which was published in the *Electrician* a few months ago stating that I had constructed a high period machine. I would say that as soon as that machine was completed I made quite a number of investigations in relation to the properties of these currents, but did not have time to put them in shape for publication.

In regard to the experiments with the incandescent lamp bulb and the strip of filament mounted on a single wire, I cannot agree with Mr. Tesla at all that conduction through the glass has anything to do with the phenomenon it presents. It is well known that an incandescent lamp bulb if held in the hand is capable of acting as a Leyden jar and will receive and retain a charge from a static machine of very high potential, and that a very violent Leyden jar shock, with a long spark, may be obtained by bringing the free hand towards the neck while holding the bulb after charging, as mentioned. If conduction through the glass were a possibility this action could not occur.

Mr. Tesla thinks that I have misunderstood his statement about the limit of audition. From my point of view I think that he has misunderstood my statement about it. He had stated that he had experimented with 10,000 to 20,000 alternations per second. I pointed out that this would correspond to 5,000 to 10,000 complete waves of sound, and equally, I may now say, complete waves of current. The limit he had adopted, or suggested, was about 10,000 waves a second. It is evident that his experimenting with from 5,000 to 10,000 complete waves would be working below this limit of audition, even taking the low value which he had suggested for it. I have heard sounds of 20,000 complete waves per second. The physical cabinet of the Central High School, at Philadelphia, contained, at the time of my connection with the institution, apparatus which enabled a test of one's hearing powers in this respect to be easily made.

I agree with Mr. Tesla that the success of an arc light system depends upon good management; and I include in the term good management, good design, good construction, good supervision, and good commercial work, which includes the ability to stand considerable bad management in the running.

Five or six years ago it occurred to me to try the construction of a dynamo for constant current in which the armature coils were of a highly efficient type, that is, of comparatively short wire length for the voltage and moving in a dense magnetic field. Exteriorly to the coils, and to the field, I had placed (in the circuit of each coil) an impedance coil, which consisted of an iron core wound with a considerable length of wire and connected directly in circuit with the armature coil. I thus obtained, as I thought, the property of considerable self induction along with efficient current generation, and by separate devices, I expected that possibly the effects would be very much the same as those obtainable from the regularly constructed arc apparatus. In this I was disappointed. The effect was to shift the diameter of commutation forward and to lower the capacity of the machine, while the properties otherwise were not so greatly changed. The requirement in the arc machine is simply that there shall be a droop or dip in the characteristic curve at about the point of normal current, and at a rate dependent upon the character of the lamps used with the machine. Differential lamps require for stability less droop or dip than lamps feeding entirely by the shunt or derived circuit. Without doubt, arc machines give better effects when the field magnets are in series, not only on account of the resistance of such magnets, but also because of their self induction tending to smooth out and obliterate vibrations or undulations of current which would otherwise have a direct passage from the commutator brushes to the circuit.

Mr. Tesla has evidently misunderstood my meaning when I spoke of the introduction of a coil of large self induction in series with arc lamps as not affecting their feeding. I had no reference to any instability of current "involving large variations, and occurring at large time intervals," in this case, as the machinery I used was of a stable character and did not give rise to the instability at which he here seems to hint. I meant that a coil of large self induction cut down, or wiped out, vibrations or undulations of current and reduced them to a very slight amount, *i. e.*, prevented them from existing in the circuit, just as such coils will wipe out the waves of speech in a telephone circuit, only the effect here is, of course, on a larger scale.

In relation to the feeding of a lamp which operates by a clutch, I do not deny that a slight vibration of the parts will, or may, benefit the feed, but I think the same slight vibration will benefit the feed of the clock-work lamp also. On this point Mr. Tesla contented himself by simply saying that he cannot agree with me, and that he thinks these vibrations do not at all benefit a clock-work lamp. I disagree with him there, because I think they *must*, as the vibration tends to keep all the moving parts free to act and avoid the sluggish effect of starting friction. In the clutch arc lamps of the Thomson-Houston Electric Company for many years past, the clutch has been attached only to the feed regulating lever by an elastic spring, and the result of this spring suspension or elastic connection (the properties of which I discovered as far back as 1879 or 1880) was that the feeding action by clutches was greatly improved; not, however, because the spring served to damp vibrations, though it undoubtedly did so act, but because it secured an action of the clutch which was equivalent to an automatic slip instead of a free release. In this connection I may mention that I have built and used very many forms of arc lamps of both the clutch and clock-work types.

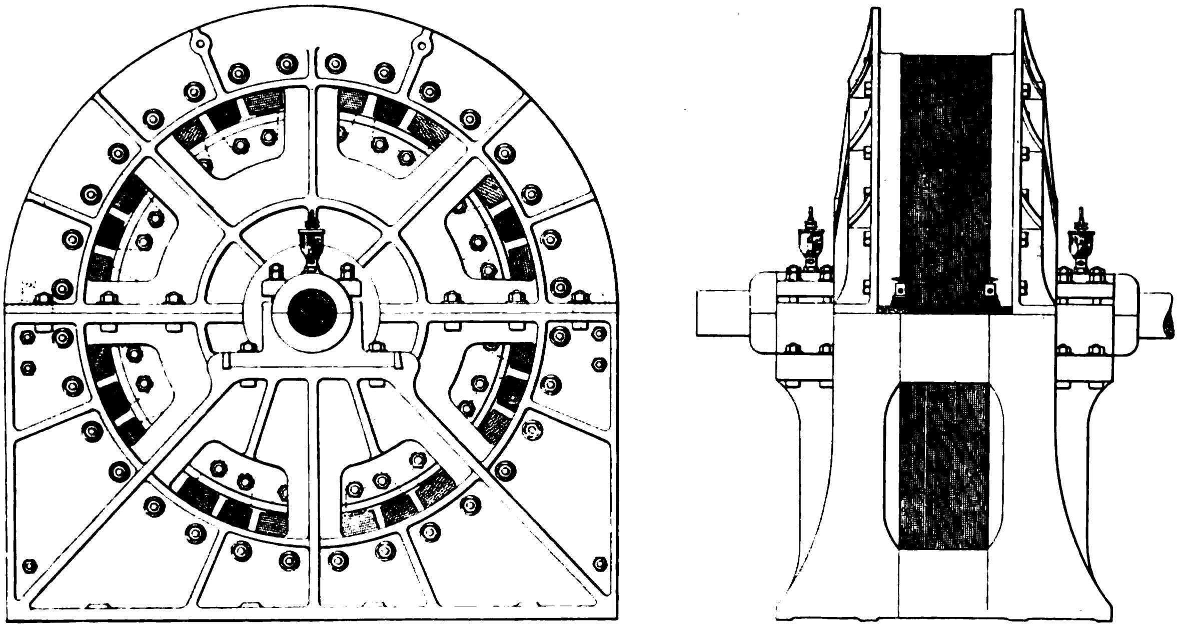
I have frequently operated clock-work lamps of Mr. Wood's construction on Thomson-Houston arc machines, and clutch lamps on machines of the Gramme type, and have, moreover, frequently run mixed circuits of lamps with several types of lamps in the same circuit on either type of machine indiscriminately. The lamps, so far as could be determined by an inspection of the arcs, worked very satisfactorily and in no way different from their normal behavior. I doubt not that there are arc plants in operation in which machines of different makes and types are interchanged, and in which lamps of different makes and different types are found mixed on the same circuit, and while this may not be very desirable always, still there is no reason why the results obtained should not be satisfactory, if the types of apparatus are good, well made and properly taken care of.

While I think it possible that the smaller physiological effect of high period alternating currents may be due to some difference in distribution, still the experiments of Dr. Tatum do not give any indication of such a result, though he sought for it. I cannot say that his experiments were perfectly conclusive on this point. From the fact, however, that the sensory nerves are to be found on the exterior of the animal body in the greatest abundance, and adapted to receive outside impressions, it would seem that the experiments of Dr. Tatum, which show that a greater amount of current at a high period could be tolerated voluntarily, are at least indicative of the fact that the current did not traverse the cuticle where the nerves are so sensitive. In such a comparatively poor conductive material as animal tissue, it appears to me very probable that the distribution of current will be determined largely by conductivity of the layers, and not by self induction to any great extent, especially as the amount or density ot the current which may in any case be supported is so very small.

I confess that my statement as to the motive of my critical remarks may have been out of place. They were elicited, however, by Mr. Tesla having on a former occasion misunderstood my motives and having acted on that misunderstanding.

THE "KINGDON" INDUCTOR DYNAMO.

The accompanying illustrations, Figs. 1 and 2, represent one of the 70 unit alternating current dynamos designed by Mr. J. A. Kingdon for the central station at Woking, England. In this machine the coils, which correspond both to the armature coils and to the field magnet coils of an ordinary alternating current dynamo, are fixed, while the revolving wheel carries a number of laminated masses of iron or inductors, which produce by their motion magnetic changes in the iron cores of the armature or secondary coils. The magnets of the dynamo are built up of a number of stamped iron plates, each plate being of the shape shown in Fig. 3, and having four projecting core pieces. These plates are bolted between two stout cast-iron frames, which also carry the pedestals. The machine is divided horizontally along the centre lines, so that the top can be lifted off and the wheel taken out. There are thirty-two magnet cores projecting from the magnet ring, and sixteen of these are fitted with the primary or exciting coils, and sixteen with the secondary coils in which the alternating current is generated, primary and secondary coils being placed alternately. In the diagram, Fig. 3, the poles marked N S N S are primary poles, and are magnetized by means of an exciter with the polarities indicated. The intermediate poles *n s n s* are the secondary poles, and have their magnetism constantly changed as the inductor wheel rotates. The number of inductors, which consist of a number of stamped iron plates bolted between two steel discs carried on a hub on the shaft, is sixteen, being equal to half the number of the magnet cores.



FIGS. 1 AND 2.—KINGDON INDUCTOR DYNAMO.

The action of the machine is as follows:—In the position of the wheel shown in Fig. 1, the secondary poles have the polarities indicated, being magnetized by the primary poles with which they are connected through the inductors. When the inductor wheel has rotated through one thirty-second of a complete revolution, the secondary poles will all have their polarities changed, being now magnetically connected through the inductors, each with the primary magnet on the other side. The inductor wheel thus acts as a magnetic commutator, and, as it rotates, continually changes the polarities of the secondary magnets. Alternating currents are accordingly generated in the coils wound on the secondary magnets. The polarity of the secondary magnets being changed thirty-two times during each complete revolution, the number of alternations per revolution is thirty-two, being equal to twice the number of the inductors, and being quite independent of the number of primary or secondary coils.

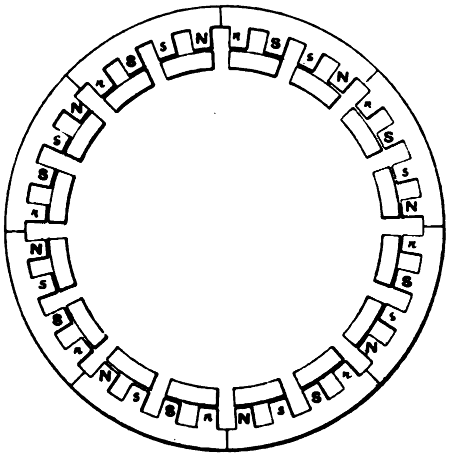


FIG. 3.—KINGDON INDUCTOR DYNAMO.

The dynamos at the Woking central station are coupled direct to triple-expansion engines running at about 260 revolutions per minute. The periodicity of the machines is therefore 70. Each machine is divided into halves, each half giving 15 amperes at 2,000 volts at the speed mentioned. Either the top half, or the bottom half, can be used alone or the two halves may be used together as one machine. When the load on a machine is less than 30,000 watts, one-half only of the primary magnets are excited, and current is taken from the corresponding secondaries. The principal dimensions of the machine are:—Length, 6 ft. 8 in.; height, 6 ft. 8 in.; width, 3 ft. 9 in. The inductor wheel is 4 ft. 6 in. in diameter. The inductors measure 12 in. by 8 in. on the face. The magnets are 8 in. long, and measure 12 in. by 3 in. on the face. The resistance of eight primary coils connected in series is 2.7 ohms, and of eight secondary coils 1.8 ohm. The total weight of the machines is about 7½ tons.

The Kingdon inductor dynamo is manufactured by Messrs. Woodhouse & Rawson, United, Limited, of London, at their heavy engineering works at Kidsgrove, near Crewe, where also the engines and boilers for the Woking central station were made.

THE WESTINGHOUSE AUTOMATIC STREET CAR LIGHTNING ARRESTER.

Besides the thorough insulation of the electric motor and its protection from abnormal currents due to short circuits, provision must also be made to guard against the effects of lightning. A successful lightning arrester must fulfill two prime conditions; in the first place it must act so as to carry off the high potential static discharge without offering an appreciable resistence to the discharge, and, secondly, it must be so constructed that it can break the circuit to earth and take care of successive discharges without requiring further manipulation or personal attention. The first condition is best fulfilled by so constructing the arrester that it embodies no coils, which, by the self-induction created in them, would impede the passage of the discharge. This and the second condition have been combined in a very simple and effective manner in the lightning arrester designed by the Railway Department of the Westinghouse Electric and Mfg. Co., and which is now being mounted on all their electric cars.

The arrester, which is illustrated in the accompanying engraving, consists of two air chambers, A and A^1, having vents, shown at H and H^1, through which the curved carbon B hinged at K, can freely pass, swinging from O to O^1. The carbon point O is set so that it is separated from B, when in its normal position, as shown in the figure, by one-sixteenth of an inch. The distance from O^1 to B, is likewise one sixteenth of an inch, when the curved carbon is in the other chamber. The carbon B is connected to the ground G^1, and the carbon O and O^1 to the motor at D. F is a lead fuse, and E an insulating block, provided with a slot, through which the lead fuse is passed. The points C and D are connected in series with the motor.

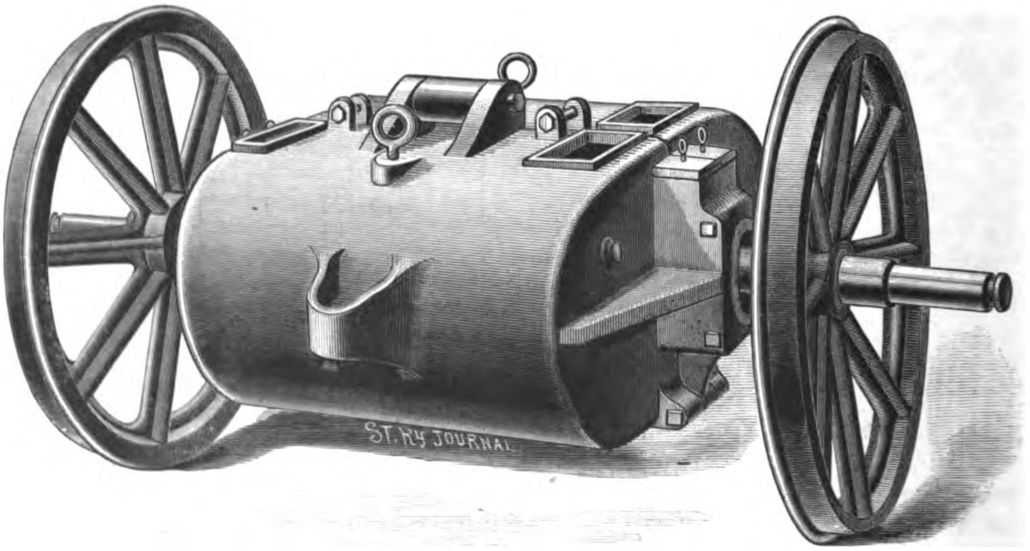
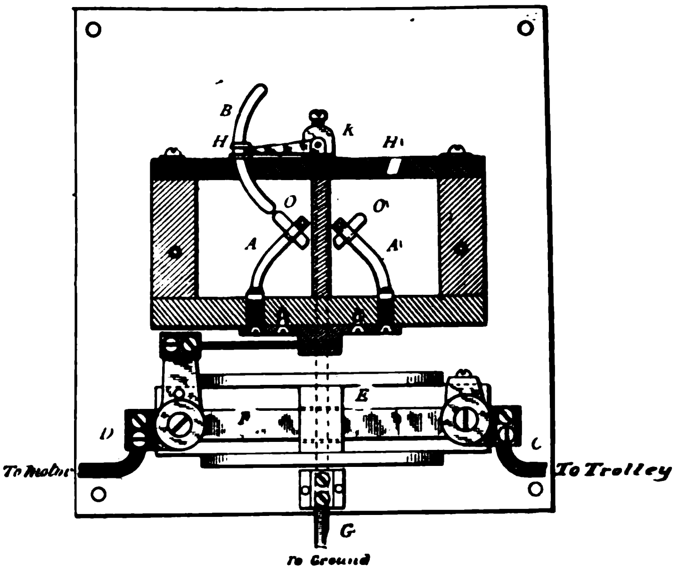


Fig. 1.—Diagonal View of Westinghouse Gearless Motor.—(See page 389.)

The action of the arrester is as follows: When a discharge takes place, it passes through the lead fuse F, to one of the carbons, O or O^1, depending upon the position of B; then across the air space to the curved carbon B, and from there to the ground, as shown in the figure. The dynamo current, then following, causes an arc to be established between the carbon B, and O or O^1. The heat generated by this arc expands the air in its respective chamber, increasing the air pressure therein, and causes carbon B to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge.



Westinghouse Street Car Lightning Arrester.

In testing upon this arrester, 500 volt and 1,000 volt generators have been repeatedly short circuited through it. In every case the circuit has been instantly broken without injury to the dynamo, and the arrester has as quickly set itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, carbons O and O^1 were so adjusted as to touch carbon B, in either of its two normal positions. A 1,000 volt generator was then short circuited through the arrester, which resulted in the circuit being several times automatically opened and closed in one second without injury to either dynamo or arrester.

THE NEW WESTINGHOUSE IRONCLAD GEARLESS RAILWAY MOTOR.

It is but a few weeks ago that we described the single reduction gear railway motor of the Westinghouse Co.,[1] but even in that short space of time a radical change has been effected.

This has been accomplished by mounting the armature directly on the car axle so that no intermediate gear whatever is necessary, thus doing away at once with the objections which have been raised against the various methods of transmitting the power of the armature to the car axle. Two of these gearless motors have recently been built at the works of the company in Pittsburgh, and, after careful tests, have shown results exceeding even those hoped for by the designer.

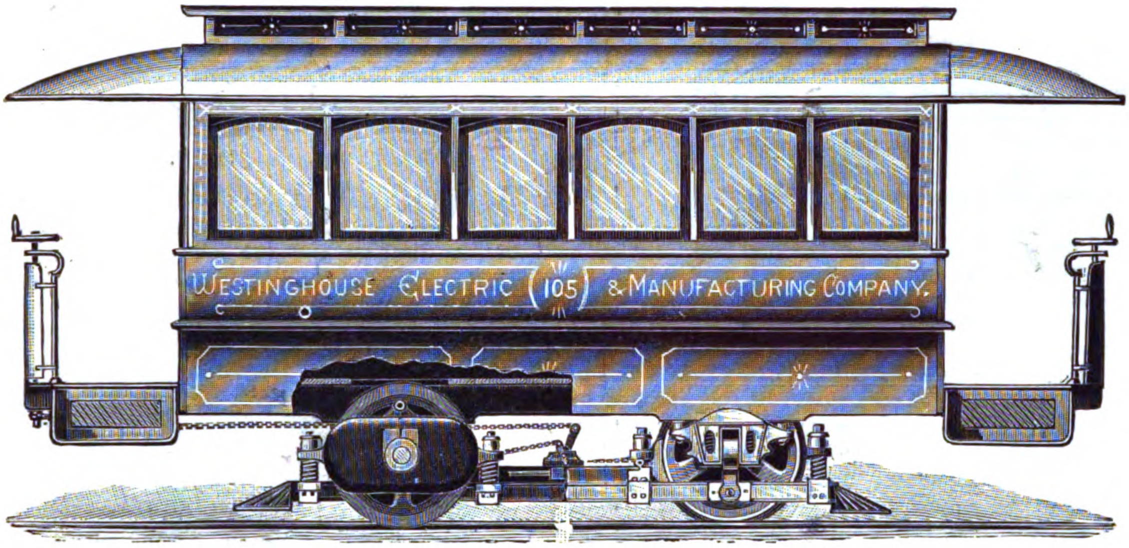

Westinghouse Electric 105 & Manufacturing Company.

Fig. 2.—Car Equipped with Westinghouse Gearless Motors.

The motor complete, mounted upon the car axle, is shown in the engraving, Fig. 1, and Fig. 2 illustrates a car equipped with one on each axle. The motor has been named the "Ironclad," due to the fact that, it is completely surrounded and protected by the field frame, which forms a natural casing designed with sufficient strength to withstand all shocks and obstructions of the roadbed. The field consists of two symmetrical castings of special iron, sleeved upon the armature shaft or car axle, hinged on top and secured together by bolts. The joints are made water-tight and the bearings are provided with leather cups for the same purpose, which makes it dust proof and possible to operate the motor on inundated tracks. The armature, which is of the drum type, is built upon the car axle. The sheet-iron discs, of which it is composed, being solid and keyed to the axle, give the axle an additional strength, which precludes any possibility of its bending. This arrangement, of course, eliminates all gearing.

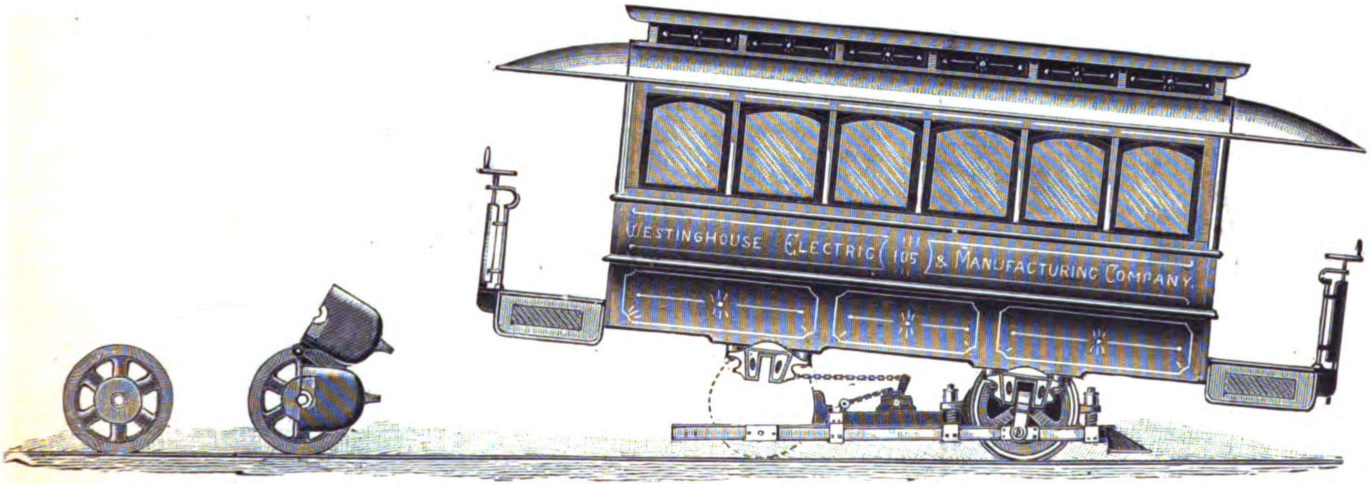


Fig. 3.—Method of Removing Motor.

The car wheels, which are cushioned, are fastened to the shaft by a novel arrangement, which makes it possible to quickly and easily replace them without any special tools or skilled labor.

The armature is but sixteen inches in diameter, with a grooved periphery for the wires, which not only increases the efficiency but holds the wires absolutely rigid. This construction has been found to be of great value for railway work, as the severe strain upon the armatures in starting the car has a tendency to displace the wires when wound upon a smooth surface.

The commutator has been designed with special reference to solidity and durability. It is securely fastened to the shaft, and the bars are connected to the armature segments by short, heavy wires designed to overcome the trouble sometimes experienced from broken connections. The brush holder, which is rigidly fastened to the frame, is of very simple design, well insulated, and easily accessible through openings shown in the engravings, which are provided with water-tight lids.

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[1] The Electrical Engineer, March 4, 1891.

It will be noticed that the weight of the magnet frame is counterbalanced and cushioned upon two powerful spiral springs which rest upon the cross bars of the truck. These springs prevent the field from rotating and give the motor the necessary flexibility for easy starting. The total depth of the "Ironclad" motor is but twenty inches, giving, with thirty-inch wheels, five inches clearance between the bottom of the motor and the rail.

One point of great importance is the ease and rapidity with which these motors can be changed. When necessary, one end of the car body may be raised by means of jacks or tackle, and by simply unscrewing a nut, the motor can be rolled out on its own wheels, and a reserve motor, ready mounted, can be rolled into its place, as shown in Fig. 3. The fields of the motor can be opened by one man, as shown in the engraving, and the armature at once liberated. For all this no pit is required, and the work can be done intelligently and conveniently.

Actual tests have shown a working efficiency of the new motor of over 90 per cent., which is further substantiated by the fact that after two hours' run with a load of over 20 h. p. the rise in the temperature of the armature and field coils was only thirty degrees above the surrounding air. All sparking has been avoided by the excellent electrical design. This form of motor is free from leakage and external magnetism, and on account of the absence of gears, it is estimated that at least five h. p. per car is gained over the double reduction motors, with a corresponding diminution in coal bills; or, on the other hand, allowing more cars to be operated by the same generating capacity. The wear, tear and maintenance on cars equipped with these motors, it is expected, will be greatly reduced on account of the low speed of the wearing parts, small inertia of the armature and the low peripheral speed of the commutator. The comparatively light weight of the equipment, dispensing with the weight of an elaborate truck, permits of the use of a very light truck, and the "Ironclad" can be adapted for any gauge from three feet up.

This motor, as well as the four-pole single reduction motor, was designed by Mr. Albert Schmid, superintendent of the Westinghouse company, and both bear testimony to his ability.

THE WIGHTMAN TROLLEY ARM.

ALTHOUGH many of the complaints against the unsightliness of overhead electric railway wires are no longer heard, electric railway engineers are still at work improving the present methods of construction, both of the overhead lines and of the attachments by which current is conveyed from trolley to car. Among those who have devoted their attention to this branch is Mr. M. J. Wightman, of Scranton, Pa., who has recently devised the novel arrangement of trolley arm and wire, illustrated in the accompanying engravings.

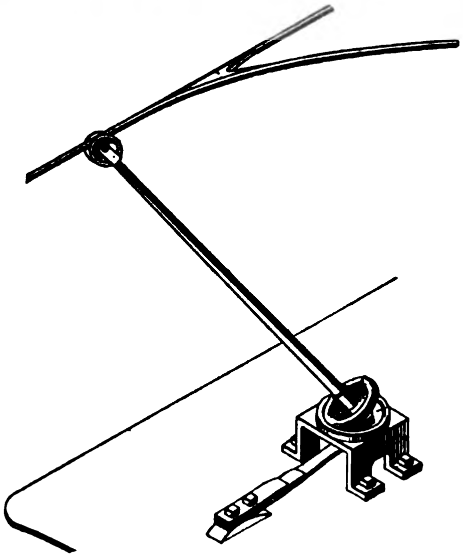

FIG. 1.—WIGHTMAN TROLLEY ARM.

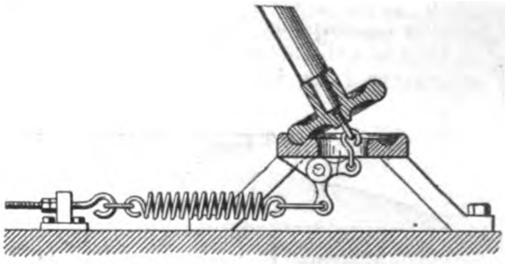

FIG. 2.

As will be seen in Figs. 1 and 2, the construction of the trolley arm is such as to afford it a universal joint at its point of support, and the arm may be readily inclined in any direction and will always have a spring-pressure exerted upon it, tending to restore it to a vertical position. In this way the pressure of the trolley against the trolley-wire will always be in a plane parallel to the wire, and the trolley-wheel will always be carried in a plane parallel to the wire, so that the possibility of derailment is greatly reduced. The point of application of the power exerted by the spring-tension device being at the centre of the fulcrum-disc, the fulcrum will be changed in relation to the power-point during the different movements of the trolley-arm. When the trolley-arm is inclined in one direction and then is moved over into an opposite position, the fulcrum-point is changed from one side of the power-point directly to the other.

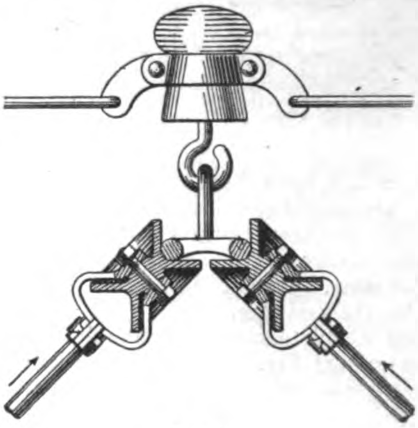

FIG 3.

As the greatest pressure should be in the plane parallel to the trolley-wire, and the least in a plane at right angles thereto, the fulcrum disc and bearing plate are made elliptical in outline. By placing the long axis of the disc and plate longitudinally with the car it will be seen that this result is attained.

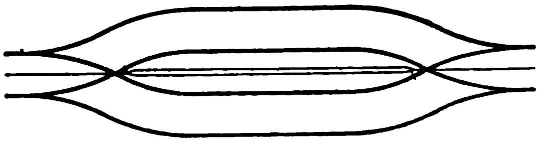

FIG. 4.

It is clear, also, that the trolley-wires, in a two wire system, may be placed very close together between the two tracks, instead of one over each, and may be supported by a single insulator, as shown in Fig. 3, the trolley bearing upon one side of the wire, instead of directly underneath. In Fig. 4 is shown a double turn-out on a single track line, where both branches come to the same point on the main line. It will be noticed that the branching points of the wires are not directly over the branching points of the track, but are so placed that the car may have sufficient lead to deflect the trolley arm from its central position, in order that it may readily run on to the branch wire.

In order to assure accuracy in diverting the trolley, and to facilitate its passage over the branching point, the wire is provided at this point with an enlargement or body, rounded on its sides and bottom, and tapered at its ends.

THE SHORT GEARLESS RAILWAY MOTOR.

Recognizing the value of a method of driving street cars, in which the difficulties encountered with gearing shall be avoided, the Short Electric Railway Co., of Cleveland, O., have designed a type of motor equipment for cars, in which the armature is mounted directly on the axle. In effecting this, special precautions have been taken to relieve the motor of all shocks, due to unevenness in the tracks, and at the same time to afford easy starting of the car.

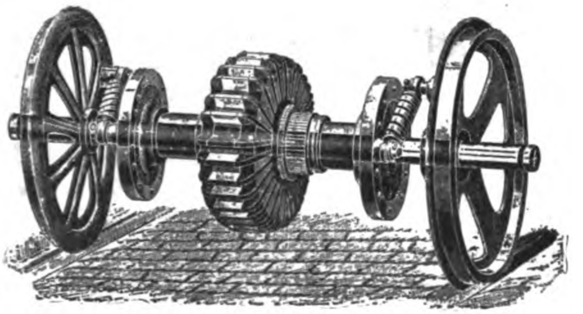

Fig. 1.—The Short Gearless Street Railway Motor.

The manner in which this has been carried out will be readily understood by reference to the engraving, Fig. 1. As will be seen, the axle runs through the armature shaft, which is of steel and is hollow, being 6 inches in outside diameter and 5 inches internal diameter, leaving an air space around the axle. In the centre of this shaft the armature and the commutator are fastened, and on each end of the armature shaft are keyed heavy crank discs, made with an iron hub and rim, and a wooden web similar to the gears which have been used by the Short company. This thoroughly insulates the armature shaft from the rim of the crank wheel. In order to avoid shocks in starting, the crank wheel rim has upon one side a crank pin, as will be seen in the illustration, and the car wheel also has a crank pin, and between the two is stretched a heavy coil spring, capable of pulling, with a very slight elongation, 2,500 or 3,000 pounds. The power of the motor in turning the wheel is transmitted through these springs, and the wheel is gently turned in the direction in which the armature tends to rotate.

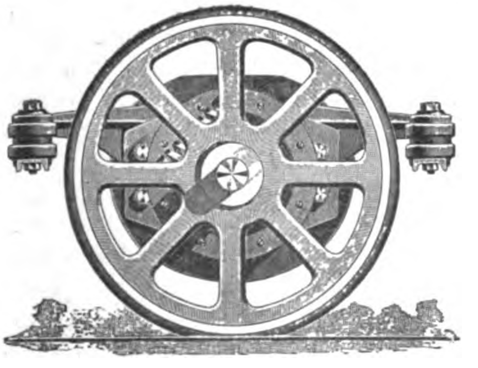

Fig. 3.—The Short Gearless Railway Truck.

Just inside of the crank discs are the bearings of the hollow armature shaft in the motor frame. By referring to Fig. 2, it will be seen that this motor frame is made of two peculiarly shaped castings of steel with arms projecting forward and backward. These arms rest on rubber cushions placed on channel bars which go from side to side of the motor frame. In this way the armature is held up in the frame and away from the axle, and the entire weight of the motor is supported by these spring cushions and by the car boxes outside of the wheels at the points where the car body is supported, none of the weight of the motor falling on the axle inside of the wheels. The spring cushions upon which the motor frame rests are limited in their movements to a fixed distance, so that the inside of the armature shaft cannot come down upon the axle. By these means the motor is carried entirely on springs and this relieves it of shock.

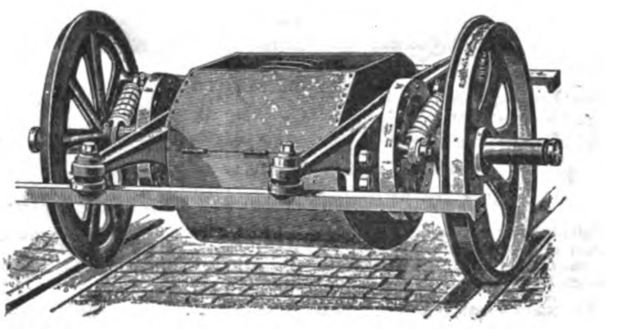

Fig. 2.—The Short Gearless Street Railway Motor.

The motor, it will be noted, is completely covered with a sheet iron casing, completely protecting it from dust and moisture. This casing is a quarter of an inch thick and is made of boiler iron hinged on each side at the top and open in the centre at the bottom, where it is held together with a latch fastening. When a car is run over the pit the casing can be opened out by removing four bolts, and the motor examined from below. The upper part of the casing is open about a foot in width next to the car floor in order to provide good ventilation.

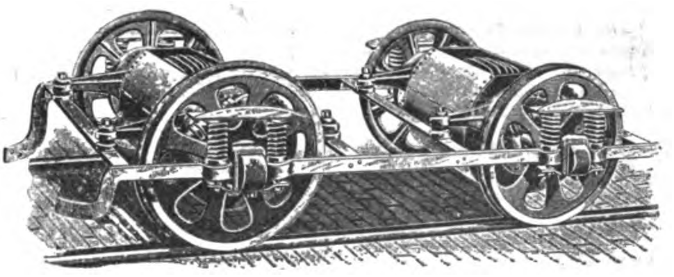

Fig. 4.—The Short Gearless Street Railway Motor.

The engraving, Fig. 3, shows an end view of the motor, and Fig. 4 illustrates a truck fitted with two gearless motors. These motors are constructed entirely of wrought iron and steel, and the weight of the new machine is practically the same as that of the standard motor made by the Short Company, and its efficiency is somewhat greater, especially at normal loads, from 5 to 10 horse power, at which a motor usually runs.

As the speed of the motor ranges only between 100 and 150 revolutions per minute, its action is practically noiseless, and the wear and tear are reduced to a minimum.

The Delaware College trustees, at Newark, Del., have voted to establish a chair in electrical engineering and one in civil engineering. The president of the college is A. N. Raub.

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Vol. XI. NEW YORK, APRIL 1, 1891. No. 152.

The barren premonitions of science have been barren because these seeds of truth fell upon unfruitful soil; as soon as the fullness of time was come, the seed has taken root and the fruit has ripened.
—Josiah Parsons Cooke.

UNDERGROUND ELECTRIC TRACTION.

We publish in this issue the careful and valuable report on underground electric traction for New York city, submitted to the Rapid Transit Commission by Mr. Frank J. Sprague. It repeats and emphasizes the ideas already expressed by Mr. Sprague, and carries the argument several stages further by dealing more specifically with the electrical side of the question. That the tunnel as built on the Greathead system in London is a success is now generally admitted; and there will soon be such a tunnel under the North river of which we can all judge at first hand. But some doubt has existed in the public mind as to the ability of electric motors to handle the heavy traffic, such as would pour up and down a New York road in the crowded hours of morning and night. Mr. Sprague has therefore done well to deal with this point, and his discussion of it is very interesting. After all, the problem has been not to build efficient big motors but economical little ones. One further point might perhaps have been touched on with advantage, and that is the absurdity of some of the comparisons made between the cost of power in operating on the elevated roads and that of the new underground electric system in London. Some criticisms we have seen take it for granted that because it costs a certain sum to carry a given small number of passengers it will cost ten times as much with ten times as many passengers. Such reasoning is obviously foolish and trivial. As it is, the London electric underground is already manifesting an economy and efficiency that command the attention of all who are concerned with the rapid transit question in our great cities. We propose to discuss this matter in detail later.

At the present moment, however, it is striking to observe how the underground electric plan is gaining favor everywhere on its broad merits. Paris is already talking of the adoption of similar methods. As our readers know, the sentiment in New York is extremely favorable, and bids fair soon to be irresistible. And now Boston has taken up the question in its usual thorough way. Following the recent example of the New York Electric Club, the Boston Boot and Shoe Club had a Rapid Transit dinner last week, given to Mr. L. Sterne, demonstrating that the liveliest interest exists in Boston on this subject. The *Boston Herald*, for example, devotes seven columns to an excellent report of the after dinner speeches. Perhaps the most important part of the record is that in which Mr. Henry M. Whitney, who has already done so much for transportation in Boston, directing a system chiefly electrical that now carries 114,000,000 people a year, gave evidence of the close study he has been bestowing on the question. It will be remembered that in order to relieve the congestion of traffic, Mr. Whitney proposed some time ago an elevated electric road for Boston. Meanwhile he has been noting closely the results in London, and in his speech he presented two reports from a special agent now in Europe and a letter from Sir Benjamin Baker, one of the distinguished engineers of the Forth Bridge, and now connected with the underground electric work in the British metropolis. Sir Benjamin states that the South London road "has proved a perfect success," with the result that another road has been authorized to run under Oxford street, from Shepherd's Bush to the Mansion House, a distance of six miles. The plans for this road approximate closely to what will be needed in New York or Boston. The trains will consist of six cars, somewhat larger than the elevated type, seating all told 336 passengers, and weighing with the electric locomotive 120 tons. The speed will be 14 miles an hour, including all stops, the maximum will be 25 miles, and the motors develop 300 h. p. at 13 miles or less. There will be at first 18 trains. It proposed to bunch all the generating power at one end of the line and to equip for a capacity of 5,000 h. p.

All this is very interesting as proof of the confidence felt in the work, and it is confirmed by Mr. Whitney's commissioner, who writes: "The public is delighted with it. They have commenced agitating the question of compelling all the underground roads to resort to electricity as a motive power. The contrast between the old and the new is so great that they do not think they can endure the old very much longer." The same feeling prevails in New York, for even should the Manhattan elevated road obtain the concessions it asks for and ought to get, only a few of the evils will be removed, while others will exist in greater vigor and banefulness than ever, being simply intensified as travel increases and as the clanging structures are hedged in by the abodes of an overcrowded and deafened population.

AN ELECTRIC STREET RAILWAY FREIGHT SERVICE.

One of the most interesting of recent departures in electric street railway work has been the freight service established on the road between Seattle and its suburb, Ballard. Mr. C. L. F. Kellogg, the secretary of the company, informs us that when the road was started, it was thought that a freight car to trail behind one of the passenger cars would pay, as the road runs to the suburban town of Ballard. This notion proved not less happy than true. The freight business soon outgrew the ordinary car, and the company now have a freight car 24 feet long over all, the length of body being 19 feet, 6 in. It is patterned closely after a railroad freight car, and is mounted on a Tripp truck, with two Thomson-Houston 20 h. p. motors. The car makes three round trips per day, and carries from 12 to 15 tons of freight per day. The charges for the class of freight carried will average from 12 to 15 cents per hundredweight. The car delivers freight which can be unloaded quickly at any point on the line as called for. The company are about to establish a freight office at each end of the road. They find that the service pays, over and above salaries of motorman and conductor (who is also express agent), better than any one passenger car, and a great boon, moreover, is conferred on the public of the neighborhood. It seems to us that there is an idea here worth developing in other places. There are roads designed to handle freight, and we hope soon to see the Fall River electric freight road in full operation; but this is a special innovation of unusual merit and utility. The only question or doubt that arises in our mind is as to the ability of the conductor to combine the new functions with his old ones ; but we understand that in Seattle no difficulty has arisen on this score.

GEARLESS RAILWAY MOTORS.

The rapid improvements which have signalized the progress of electric lighting are generally pointed to as one of the most marvelous manifestations of the activity of the workers and inventors of the present age, but even this remarkable record bids fair to be outdone by what might be fairly called the lightning changes and improvements that are going on at present in the department of electric railways. It is but a very short time since the double reduction gear was universally employed on street cars, and the quite recent introduction of the single reduction gear was justly hailed as an improvement, the effects of which would be widely felt. Before the single reduction gear, however, has been firmly or even partially established, we find it strikingly challenged by an arrangement in which no gears whatever are employed. By attaching the armature directly to the car axle, the designers evidently eliminate at once all the drawbacks which are the necessary accompaniment of gears. The methods employed to effect this purpose respectively in the Westinghouse and in the Short railway systems will, we are certain, attract general interest, not only among those whose work is devoted to electric railways, but even those who are only watching the evolution of electric railroading We do not hesitate to say that these new departures will have a tremendous effect in stimulating the development of electric street railways.

LAYING OUT WIRING.

The large number of new men entering the field of practical work in electricity has created a demand for practical rules and methods of construction, and this is more than usually the case among those who are engaged in the wiring of buildings. To be sure, there is an abundance of charts and tables of carrying capacity of wires and other information relating to this subject. While eminently useful in their way, such tables, in order to effect good results, both as regards evenness of pressure and economy in copper, must be backed up by good judgment in laying out the plan of wiring. Judged from this point of view, the article by Mr. Carl Hering, begun on another page, will certainly assist those engaged in wiring buildings in obtaining a correct method of distribution, and enable them to avoid errors which might lead to much inconvenience as well as loss.

Inductive Disturbances in Telephone Circuits.

We print on another page the discussion of Mr. J. J. Carty's Institute paper, by Mr. T. D. Lockwood. Mr. Lockwood takes the ground that Mr. Carty has underestimated the electro-dynamic inductive effects. In this connection it may be of interest, in support of Mr. Carty's theory, to point out the recent phenomena observed on high tension alternating circuits of considerable capacity. It has been shown that under these circumstances the condenser action is especially marked and that the circuits are influenced by static charges which are not met with in continuous current working. When we consider the high rate of alternations produced in telephone circuits, the analogy between the phenomena observed becomes apparent, and it would be well to determine, if possible, the exact extent to which this action shall be given weight in the theory suggested by Mr. Carty.

"Alium" for "Aluminum."

The tendency to drop the extra "i" in aluminium has already become general, but a good deal of dissatisfaction is felt with the shorter form as not being short enough. "Alium" has therefore been proposed, and the suggestion has come from three different quarters, namely, Mr. Eugene Cowles, Prof. Elihu Thomson, and Mr. Oberlin Smith. The latter gentleman, it may be mentioned, read a paper some time ago before the Institute of Mining Engineers, proposing "alium" as a "nickname" and giving some excellent and ingenious reasons for it. The other two suggestions on the subject seem to have been made more recently, but quite originally, that of Prof. Elihu Thomson appearing in a letter in our own columns. We are perfectly willing ourselves to accept "alium," if only as being shorter and easier to write or read, but what is required on such a subject is not further diversity, but unanimity. If all the technical journals the same week began to call the metal "alium," that would settle it. We are ready. The co-operation of the technical journals and the scientific societies on matters of this kind would go far to prevent and remove divergences and to unite usage upon a common standard whether of spelling or of meaning, and there is no reason why joint efforts in this direction should not be made.

A REPORT ON UNDERGROUND ELECTRIC TRACTION FOR NEW YORK CITY.[1]

BY FRANK J. SPRAGUE.

IN presenting my views on rapid transit I shall briefly outline what has seemed to me, after several years of experience and study, to be the best ultimate solution of the question for New York city. For some of the details of, and arguments for, this proposed system, and especially for electrical statements, I am obliged to refer you to attached papers, written at various times, in which I have set forth my views more elaborately than time now allows, and especially as I appear before you in a dual capacity; first, as the advocate of a specific method of tunnel construction adapted to meet our local needs, and second, as an electrical engineer.

The essentials of the system I favor are:

1st. An underground system, because in this way only can we be independent of all surface limitations.

2nd. An iron tubular construction, because it is the strongest, requires less excavation, will give a more perfect roadbed, can be run near the surface, will interfere least with existing or future foundations, and is the only safe system of tunnelling for passenger traffic, where sewer, steam, water, gas, and other leaky and earth saturating pipes exist.

3rd. Independence of way and express track systems on the main line in New York, because rapid transit and freedom from crowding can only be had with a four-track system, with sufficient intervals on one set of tracks between stations to allow of the attainment and maintenance of a safe high speed with any reasonable power.

4th. Independence of tunnel paths for all tracks, because in this way a stronger construction can be had, obstructions more easily avoided, work more readily prosecuted, way routes be so run as to best accommodate way travel, and express routes run by shortest paths subject to express station intervals only.

5th. Way stations between tracks, and express stations at intersections of way and express tracks, the latter being the lower and with access to trains from common platforms.

6th. Electrically operated trains, because the use of the electric motor will be cleanly, noiseless, safe, and more economical, and because it is the only practical method of operating a tunnel system as here proposed at high speeds and for long distances.

7. A continuous train service without necessity of reverse switching.

In brief, then the system I propose is: An independent and way express service; each having double tracks, but having independent paths, run in independent circular iron tunnels, and forming a loop around the city from the Battery to Jerome Park. The express and way routes to intersect or join at different levels at common stations, and the trains to be lighted and operated by electricity. Way trains to have stations about every third of a mile, express every mile and a half, a loop to be provided just south of the Harlem river. There should also be a cross-town two-track system, running beneath the city division, intersecting it on the east and west sides on the Forty-second street line and at the Battery, and making connection with the Long Island, Broadway and Atlantic avenue stations and the street railway lines in Brooklyn, the trunk line depots and street railway systems in Jersey City and Hoboken, and whatever additional underground systems might be developed in the future. A two-track system for this loop would practically provide express service, because on a larger portion of it, that under the rivers, there would be no stops, and the station intervals would be sufficiently long to allow of high speed.

If the elevated railroad system is a permanency in New York, its service can be vastly improved by the running of a double line of tunnels for express service, its route intersecting the elevated system at certain common stations, with elevators running from the elevated platforms to the underground platforms and stopping at street levels, passengers to exchange from one system to the other on one fare; but there is already too little station room, and I believe the success of an underground system will be so pronounced that two such tunnels would be followed by two others and the routes of such an underground system should not be subservient to the elevated routes, which do not properly serve either Broadway, the west side of the city, or the annexed district.

The details of the underground system of tunnelling here proposed, which is known as the Greathead system, but which would be modified for New York city, have been presented to your honorable board by its representative, Mr. Louis Sterne. My interest in it, until very recently, has been purely scientific, and my approval of it unbiased by any connection with it. Within the past week, however, I have somewhat suddenly and unexpectedly been called upon to become one of its active supporters and representatives in this country, and now am such, but it is not primarily in that capacity I appear before you at the present hearing, but rather as an electrical engineer of varied experience, and because I have been somewhat active in creating the present development of electrical railways, and I wish to remove as far as possible the apprehension which I find voiced by some of the daily press as to the availability of electricity for work of such severe character as must distinguish the future rapid transit system of this city, so as to leave the decision of other questions untrammelled. I am led, moreover, to speak particularly of the use of electricity, because in most of the schemes for rapid transit brought to your notice its use has either not been seriously considered at all, or, if it has been considered, its adoption has been simply assumed as a matter of course, while few reasons, either historical or practical, have been given for this assumption, and hence your board has been left without that detail knowledge, so far as it has been published, which would be of service in arriving at a fair conclusion.

I understand that the objections raised are that the science is new, that motors of as large capacity as would be required to handle loads now carried on the elevated railroads have not been used in railway work, that unsuccessful experiments have been made on the elevated system, and there is a doubt about the economy of operation. These objections are not insuperable, and a brief statement of the history of the development of electrical railways of this country, a statement of what has been and is being accomplished, and some general remarks about steam and electrical analogies will, I think, show this.

The first serious proposal in this country for the operation of an electric railway motor by current through the rails was made, I believe, about twelve years ago by Field. One of the earliest private experiments was made on a track at Menlo Park in 1880 by Edison. The Electric Railway Company of the United States in 1883 exhibited a railroad in operation at the Chicago exhibition, and in the same year Daft made experiments at Greenville and Mt. McGregor. In 1884 small roads were built and operated by Daft at Coney Island and in Boston at the Mechanic's Fair, and in 1885 the same inventor opened the first regularly operated line in the United States at Baltimore. In the winter of 1882–3, and the fall of 1883, Van Depoele ran experimental lines in Chicago, and in 1884 and subsequently he operated an exhibition line at Toronto. Afterwards he equipped a number of roads. In 1884 experiments were made by Bentley and Knight, of Cleveland, and Sprague exhibited special motors at the Franklin exhibition in Philadelphia. In 1885, and again in 1888, the Daft Company experimented on the 9th avenue elevated division. In 1886 the Edison-Field interest revived experiments in elevated railroad work, but they were soon abandoned. About the same time Sprague and Johnson experimented on the 34th street branch of the elevated railroad. Two 1,200 lb. motors, each geared directly to the axles of a single truck, propelled two elevated cars up the maximum grade, and many experiments were made to demonstrate methods of electrical braking, etc. In 1888 Field resumed experiments on the same branch. In 1887 Sprague, in New York and Boston, and at St. Joseph, Mo., following out the practical outline on the elevated railroad experiments, started street railway work.

Such is a brief résumé of the work done in this country for the first seven or eight years of the twelve which have elapsed since the first crude suggestions of a working system. Nothing is so marked as the varied character of this work, all of which may be termed experimental. Every one of these experiments in their early form have been abandoned, either because of the development of better machines, more practical methods, or lack of financial support, or because they were ill-timed. Especially is this last reason true of the elevated road experiments which were attempted while the more urgent and commercially important street railway work was almost untouched and the whole science of dynamo and motor construction was undergoing a most rapid evolution. It was not until the years 1887 and 1888 that the movement took place which was the precursor of the present development of electric railways, and which makes the application of electricity to the future rapid transit system of this city feasible. This was the opening, in February, 1888, of the Richmond Union Passenger Railway by the Sprague Electric Railway and Motor Company on the lines of motor development shown by the Sprague experiments on the elevated railroad in 1886. This road, which cost the electrical company $160,000, the larger portion of which was lost, was the first great system operated by electricity, and the difficulties and problems there overcome forever settled the supremacy of electricity as a motive power.

The development, which in the last three years, has followed the inauguration of this road has been almost unprecedented, so that there are now in operation or under contract on the lines laid down at Richmond not less than 325 roads in the United States, England, Germany, Italy, Australia and Japan, requiring over 4,000 cars and 7,000 motors, with 2,600 miles of track, with a daily mileage of not less than 400,000 miles, and carrying three-quarters of a billion of passengers annually. Grades of thirteen and fourteen per cent., distances of six miles or more from the central stations, speeds as high as from 25 to 30 miles per hour for single cars, trains of from one to four cars characterize their operation. Not less than ten thousand people represent the number employed on these roads. Fifty millions of capital invested in this country alone, and a present annual business of not less than eight to ten million dollars on the part of the manufacturing and contracting electrical companies show the present standing of the street railway work.

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[1] Presented before the New York Rapid Transit Commission, March 15, 1891.

These figures should be sufficiently significant, but it may very properly be asked, "Have there not been many troubles? Are not changes being constantly made, new machines being designed, and will not the building of larger machines than those already made be attended with some difficulties?" It would be folly to reply to these questions except in the affirmative, but that is true of the development of every machine. Many of the difficulties incurred are due to the rapidity of the commercial development which has made it necessary for the manufacturing companies to put out motors in great quantities without correcting the troubles which must necessarily appear when machines representing a new art are put into practical operation under the most varied and severe circumstances.

But the development of the motor of the future is clearly outlined and will be most rapidly carried out. Let us consider in this connection the existing steam locomotive and the development of the dynamo machine. Every locomotive is really a combination of a boiler and two engines, independent in all things, save that they are connected to a common driving axle, which two engines continually work under a load which varies in every portion of their cycle. The principles governing each of these engines are precisely the same as govern the operation of any other steam engine, but although thus similar, and although there are hundreds of forms of steam engines, high speed, low speed, simple, compound, triple and quadruple expansion, condensing and non-condensing, built for various classes of duty and with a view of getting a certain output with a certain expenditure of coal, the use of which being determined largely by the relative value of coal economy and other commercial considerations, common practice has outlined one general type of steam locomotives, the one with which we are all familiar.

The varieties of types of steam engines do not, however, cast any doubt upon the adaptability of steam engines for traction, nor does the fact that the elevated railroad carry engines of a combined capacity with two cylinders of 185 horse power, which is the capacity demanded for its particular duty, alter the fact that any standard locomotive works is perfectly able to build locomotives of 1,000 horse power, or as much more as may be required, and that, too, under limitations which do not exist in the building of electric motors, because the locomotive has to carry its own boiler, furnace, water and fuel.

The fact that electric motors of large size have not been commercially introduced for railway work is simply because there has not been a demand for them; the art, both scientifically and commercially considered, has not warranted the experimental expenditure demanded in the evolution of the larger types of machines. The commercial sense dictates this development, and as soon as your board shall have determined on a system of rapid transit which shall require the use of motors of large capacity, you may rest assured that such motors will be promptly forthcoming. Your decision will give an impetus to this development because it will open the opportunity which will be eagerly grasped by hundreds of intelligent, enthusiastic electrical engineers, backed by abundance of capital. All that is necessary, I repeat, for the creation of this larger type of machines, is that the commercial need should exist for it. This is the history of every mechanical appliance, no less the steam engine than the electric motor. Who would have dreamed a few years ago of such magnificent specimens of engines as the 15,000 horse power triple expansion engines which to-day propel our fast ocean steamers?

Already steam engines are being built of size and capacity to accommodate the demands made upon them by the dynamos of the future. The machines of from 200 to 400 horse power capacity which are now being built in this country are of a capacity not called for and not seriously considered some years ago. In Berlin, in the finest electrical stations in the world, dynamos of 500 horse power capacity are driven in pairs by engines of 1,000 horse power, and the whole construction shows that as much reliance is placed upon the perfection and durability of the dynamo as upon the engine itself. A striking comparison, both as to size, appearance and simplicity of dynamos and engine, is shown by the most casual glance at one station, a partial photograph of which I have here; the dynamos have got a far greater temporary capacity than the engines themselves.

I may say in passing, that this photograph will give an approximate idea of one of the units which I have in mind for the future central station of the electric rapid transit system of New York. Two stations, each with three units as here shown, would effectively handle the entire traffic of the Third Avenue Elevated Railroad, with its 63 trains and locomotives of an aggregate capacity of 12,000 horse power. At the Deptford station, in London, engines and dynamos of 10,000 horse power capacity are under construction. If dynamos of these capacities can be built, in the operation of which millions of dollars are invested, what is there to prevent building motors of any required capacity to meet your demands? There is none.

After all, what is a dynamo and what is a motor? Nothing more or less than the application of two different names to the same piece of apparatus, each of which specifies the purpose for which it is used. When we apply power to this machine and produce by its rotation electrical energy, we call it a dynamo, and when we put current through the same machine and by its rotation apply power to a driven shaft, it is a motor. Its electrical function is absolutely the same in both cases; its efficiency of conversion almost identically the same, and very high. As there are many types of dynamos varying in form to meet commercial and manufacturing demands, so there are various forms of motors, and when this machine is so used, especially for railroad work, on account of the rapidly varying and difficult character of the duty, the necessity of comparatively light weight, and freedom of accessibility for change of parts in emergency, it is advisable to have a special construction; but even here, the electric motor has a freedom of application entirely denied to the steam locomotive, which must work within certain prescribed lines.

After all, how small the advance which is necessary to get the required capacity for operating any rapid transit system required. The elevated locomotives, handling trains of a gross weight of 90 to 105 tons, carrying sometimes as high as 500 passengers, and capable on a half mile stretch of attaining a speed of 30 miles an hour, have two cylinders, each of about 90 horse power. Thousands of street railway motors of 15 and 20 horse power are in daily operation, nearly always in pairs.

Double the lineal dimensions of a 10 h. p. motor and it becomes an 80 h. p. motor, and two of such machines controlled by a single switch will do the work of an elevated locomotive; but not only two but one hundred, if necessary, of such machines can be controlled by a switch. Double the lineal dimensions of a 20 h. p. motor and it will become a 160 h. p. motor and will easily work up to the capacity of the elevated locomotive. This increase of capacity with increase of dimensions is an imperative law and governs many other classes of machinery. Stationary motors working up to 50 and 100 h. p. are now rapidly being adopted, and much larger ones will soon be in use.

I repeat, there need be no hesitation on the part of your board on the question of electric traction, because of any apprehension that the electric motor development will be found wanting when demanded.

On the City and South London Road the entire central station and electric motor equipment was finished before the tunnel was ready for use, notwithstanding the fact that when the tunnel was originally designed a cable was intended for the motive power.

But I will go further than mere assertion that the required development will take place, and I will, as far as may be, determine the matter by reference to that criterion which alone governs almost all decisions of this character, the possibly hard, but the entirely just, one of dollars and cents, for I am ready, if a rapid transit system be adopted requiring the use of the electric motor, to undertake the entire contract for the necessary steam and electrical equipment for not less than fifty way and express trains operated as I have outlined, under satisfactory guarantees of efficiency and cost of operation as compared with steam practice.

THE FOURTH AVENUE TUNNEL.

The N. Y. State Railroad Commission, having completed the investigation of the accident in the tunnel, recommend, among other things, improvement of the audible signal at the home signals, and the adoption of the torpedo in addition thereto; constant inspection of the lights and wires moving the signals, and the use of an electric device to show to the operator in the cabin the position of the signals; the adoption of a rule that no engineer or fireman shall be permitted to run a locomotive through the tunnel until he shall have a certificate of perfect eyesight and perception of color, and a reduction of speed to fifteen miles an hour, the rate to be still further reduced under unfavorable conditions.

It is proposed to string some incandescent lights through a section of the tunnel and note the effect.

THE INCANDESCENT'S STILL SMALL VOICE.

One of the late London inventions, says an exchange, is the "silent call," an invention in connection with electric lighting. Two lamps are suspended outside the building, one red and the other green, and by pressing a button in the entrance hall, one or the other of the lamps can be lit at will. The red light summons a four-wheeler, and the green a hansom cab.

ARC LIGHTS ON THE NORTH POLE.

Hammerfest, the most northerly town in Europe, and situated within the Artic circle, is one of the first places in Norway to be completely lighted by electricity. A waterfall a mile distant from the town furnishes the power to run the dynamos. The electrical plant is of the Thomson-Houston make.

INSTITUTE DISCUSSION ON INDUCTIVE DISTURBANCES IN TELEPHONE CIRCUITS.[1]

If Mr. Carty continues to hold the views of two years back, I understand him to believe that electrostatic, in contradistinction to electromagnetic, induction is chargeable with the major amount of discredit as an agency in disturbances on telephone lines; or, at any rate, that it is a much more important agent in the development of such disturbance, whether noise or cross-talk, than has been supposed.

From long experience and observation, it appears to me that the several agencies in causing disturbing phenomena in telephone circuits which manifest themselves in the telephone receiver preponderate largely in accordance with the conditions of the circuit; that the environment (to use the language of social science) of a telephone circuit has a good deal to do with its behavior. Thus a line which has considerable leakage uniformly distributed throughout its length will suffer very little from electrostatic induction either manifested as a disturbance or as a retarding agency; not because the electrostatic induction is not exercised, or is not present; (or to put in a more modern and I think a more correct phraseology) not because inductive circuits are not formed; but because there being, by virtue of the leakage or poor insulation, an opportunity for a number of short cut or cross conductive circuits, these are utilized for the conduction of the electricity, permitting the establishment of equilibrium or discharge, at the expense of the utilization of the inductive circuits which tend to retain charge. The phenomenon exhibited, is comparable to a gallon vessel, say, in which liquid may be poured; but which has a number of holes bored through its sides. The vessel has a capacity of one gallon, but, being leaky, does not hold its charge, and the said charge is dissipated as quickly as it is formed. In this case, leakage tends if accentuated, to become the chief adverse agency, as not only does a leaky circuit dissipate induced charges quickly, but it also permits stray currents which may disturb, to come on the lines from external points.

As a matter of fact the several disturbances upon telephone lines are due to a large variety of causes. It is customary to say that the telephone is an extremely sensitive electroscope, or galvanoscope; and that it will take cognizance of almost infinitely small currents. This statement, however, should be made with some reservation.

The more correct statement is, of course, that that the telephone is a sensitive indicator of *changes* in electrical currents.

A current may be caused to circulate through its helices which is sufficiently strong to make them warm, but if that current be steady, it will not be able to produce a sound in the telephone. Telephone disturbances then, broadly stated, can result only from changes which occur in the electric condition of the circuit within which the telephone is included, and these changes may be produced by conduction from other electrical organizations; by electromagnetic induction, sometimes brought about by changes going on in substantially parallel circuits, and sometimes caused by the mechanical motion of the disturbed circuit itself in a magnetic field; as when a line swings across the magnetic meridian of the earth; and by the successive charges and discharges which cause the alternate completing and disrupting of electrostatic inductive circuits.

If we exhaustively examine the literature of the subject we shall find that the idea that electrostatic phenomena are concerned in disturbances of telephone and telegraph circuits, is by no means new. Mr. Culley presented a paper once upon this subject, before the Society of Telegraph Engineers; which paper, together with a most instructive discussion, is published in the journal of that Society, and Mr. Preece and myself from time to time have also repeatedly referred to it. It is due, however, to Mr. Carty to say that his considerations and researches in this line show him to be an original and independent thinker and observer, and that I have found his work to be instructive in the highest degree.

I think while he is undoubtedly right in attributing a large share of inductive disturbance in telephone lines, that he does not give sufficient weight to the equally undoubted fact, that electro-magnetic induction is also an important factor; and that as I have already pointed out, the conditions of any individual circuit largely govern its action. An interposed plate or an envelope of metal between the disturbed and disturbing circuits, will, if sufficiently thick, and if united to earth, screen so much of the induction as is electrostatic in its origin; but it will not screen electro-magnetic induction; and thus, whenever it is worth while, the sources of inductive disturbances can be analyzed. And while the inductively neutral metallic circuit,—the circuit with two wires closely adjacent and twisted together,—is indeed a specific against electro-magnetic inductive disturbance; it also tends to increase the retarding effect of electrostatic induction exercised between the two wires of the circuit.

Some of the considerations which tend to delay the universal employment of metallic circuits in telephony are, however, that there are an immense number of wires even when but one is used to a circuit; that twice the number of wires means twice the number to get out of order, to cross, break and leak, and consequently twice the number to take care of, and handle.

I hardly think that sufficient thought is given to these matters by many who talk glibly about the necessity and essentiality of using metallic circuits only, for all classes of telephone work.

In conclusion I wish to suggest, that inasmuch as the telephone only notes electrical changes, we cannot accurately say that sounds can be produced in it by electrostatic charge.

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[1] Abstract of a communication, by Mr. T D. Lockwood, on Mr. J. J. Carty's paper read before the American Institute of Electrical Engineers. See THE ELECTRICAL ENGINEER, March 25.

SOME FIGURES AS TO LIGHTING RATES.

As there is general interest in the question of rates paid by cities for lighting purposes, the following tables, compiled from reports made last fall to a committee of the Scranton Pa., city council, will be of interest. The first table is from cities lighted under contract by private companies.

Name of Place.	No Lights.	Cost per annum pr. lamp.	Hours Lighted.
Alliance, O.	8	$141 00	All night
Janesville, Wis.	8	100 00	To midnight
Cedar Rapids, Ia.	10	125 00	Except moonlight
Gloucester, Mass.	13	96 00	To 12 o'clock
South Bend, Ind.	14	100 00	To 12 o'clock
Union City, Ind.	22	95 00	Except moonlight
Ashland, Pa.	23	125 00	All night
Keokuk, Ia.	24	126 00	Except moonlight
Ogden, N. Y.	24	133 36	12 o'clock
Bath, Me.	27	100 00	5 all night 12 midnight
Keene, N. H.	27	100 00	To 12 o'clock
Chattanooga	30	121 66	All night
Wooster, O.	30	108 00	All night
Concord, N. H.	39	100 00	To 12 o'clock
Waltham, Mass.	32	127 00	To 1 o'clock
Jacksonville, Ill.	32	100 00	Except moonlight
Charleston, S C.	36	144 00	All night
Fond du Lac, Mich.	38	72 00	All night
Lockport, N. Y.	37	80 00	Except moonlight
Asheville, N. C.	37	100 00	To 2 a. m.
Burlington, Ia.	39	130 00	To 2 a. m.
Taunton, Mass.	44	110 40	Schedule moon
Yonkers, N. Y.	45	60 00	All night
Wilkesbarre, N. Y.	48	144 54	All night
Cortland, N. Y.	50	50 00	To 12 o'clock
Columbus, Ga.	50	108 00	Except moonlight
Vicksburg, Miss.	50	114 00	" "
Selma, Ala.	50	120 00	" "
Fall River.	60	180 00	All night
St. Paul.	50	127 75	To midnight
Lima, O.	58	100 00	To 1 o'clock
Pottsville, Pa.	58	105 00	All night
Portsmouth, N. H.	60	100 00	" "
Adrian, Mich.	63	100 00	" "
Winona, Minn.	63	125 00	" "
Hornellsville, N. Y.	64	100 00	" "
Springfield, O.	64	130 00	" "
Battle Creek, Mich.	65	85 00	To 12 o'clock
New Britain, Conn.	66	100 00	To 12 o'clock
Paterson, N. J.	70	100 00	All night
Eau Claire.	70	110 00	All night
Somerville, Mass.	70	185 00	1 o'clock
Burlington, Vt.	70	116 00	12 o'clock
Logansport, Ind.	75	100 00	All night
Mansfield, O.	77	75 00	All night
Saginaw, Mich.	80	100 00	To 3 a. m.
Joliet, Ill.	80	120 00	To 12 o'clock
Norwalk, Va.	82	70 00	To 12 o'clock
Wichita.	83	83 33⅓	All night
Northampton.	83	75 00	To 12 o'clock
Petersburg, Va.	82	96 00	All night
Newburg.	97	111 00	All night
Binghamton.	99	140 00	All night
Indianapolis	100	80 00	All night
Waterbury, Conn.	100	142 85	All night
Racine, Wis.	100	70 00	All night
Sedalia, Mo.	100	87 00	Schedule moon
Atlanta, Ga.	100	120 00	All night
Allentown, Pa.	101	100 00	Except moonlight
Galesburg, Ill.	104	105 00	All night
Boston.	105	180 00	All night
Sandusky.	115	100 00	All night
Milwaukee.	130	150 00	All night
Chillicothe, O.	121	80 00	All night
Richmond, Va.	133	146 00	All night
Lancaster, Pa.	139	124 10	All night
Zanesville, O.	140	70 00	Except moonlight
Norfolk.	155	100 00	All night
Reading, Pa.	156	146 75	All night
Akron, O.	170	78 00	All dark nights
Youngstown, O.	180	72 50	All night
Massillon, O.	180	70 00	All night
Jackson, Mich.	180	88 89	All night
Mobile.	181	91 00	Schedule moon
Bloomington, Ill.	211	108 00	All night
Poughkeepsie.	212	123 00	All night
Lafayette, Ind.	214	50 00	All night
Terre Haute, Ind.	232	70 00	To 3:00 a. m.
Harrisburg.	270	90 00	All night
Troy, N. Y.	271	158 00	All night
Springfield, Mass.	300	83 33	All night
Scranton, Pa.	322	90 00	All night
Toledo, O.	400	100 00	All night
Minneapolis.	480	150 00	Except moonlight
Philadelphia.	800	177 00	All night
New Orleans.	1,010	130 00	All night
New York.	1,357	90 00	All night

In all the above cities, with the exception Newbury, Norwalk, Richmond, Va., Northampton, Mass., Taunton, and Concord, the lamps are 2,000 candle power, and in these cities 1,200 candle power.

As stated, the above figures are for cities where the lighting is done by contract by corporations. The following are the figures in cities where the city owns its own plant:

Name of Place.	No. Lights.	Cost per year per Light.	Hours Lighted.
Martinsburg, Ind..	80	$ 40 00	To midnight
Grand Ledge......	32	62 00	To midnight
Huntington........	50	48 61	All night
Decatur, Ill........	52	60 00	All night
Dunkirk, N. Y.....	55	36 50	All night
Paris, Ill............	60	36 60	Except moonlight
Easton, Pa.........	64	100 00	All dark nights
Aurora, Ill.........	75	56 00	Except moonlight
Painseville, O......	80	35 00	Except moonlight
Madison, Ind......	85	48 00	All night
Lewiston, Me......	96	42 00	All night
Hannibal, Mo......	96	52 00	All night
Little Rock, Ark...	110	47 50	When dark
Bay City, Mich.....	134	60 00	All night
Topeka, Kan......	184	54 00	Eight hours
Topeka, Kan......	184	72 00	All night
Chicago............	292	55 60	All night

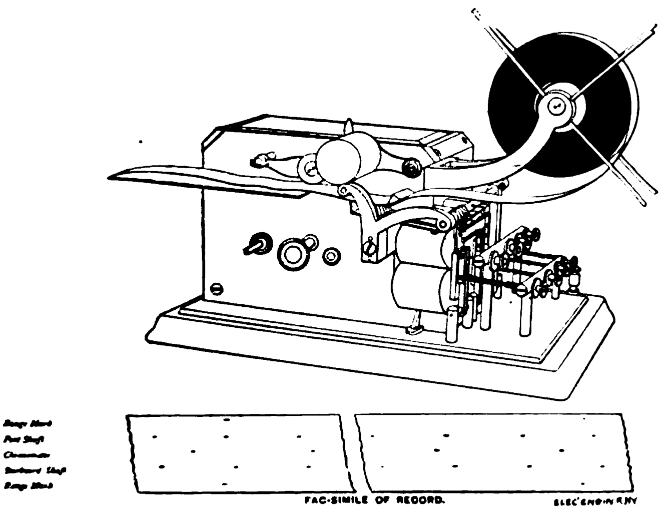
It should be added that many of the figures in the second table are utterly misleading and untrue, as no allowance is made for various items of charge and debit, and in some cases none for even necessary fuel or attendance. It is claimed, for example, that in Chicago the cost set down as $55 is actually in the neighborhood of $100. At a recent hearing on the subject in Boston, Mr. M. J. Francisco said that Chicago maintains four stations, but they do not supply the whole of the city, and now $100,000 is asked for extensions; the cost in one station about which he had collected facts, was over $100 a year per lamp, without counting in all the items of expense that should be properly charged to the electric light. The other places cited showed higher cost than this, with a few exceptions, the cost in most small cities being about $120 per lamp per year. Marietta, O., and Parkersburg, W. Va., only 12 miles apart, have about the same conditions for lighting; Marietta's municipal plant costs 4¼ cents per night, and Parkersburg pays to a company only 2¼ cents. Mr. Francisco also called attention to some other considerations affecting the question; if a private company, through accident, lightning or storm, cannot furnish the light it has to give a rebate to the city, and the company has also to meet expenses from wires blown down, etc. No estimate of such expenses has been put into the cost as given by the advocates of municipal ownership.

REGISTER FOR SPEED TRIALS.[1]

BY ASSISTANT ENGINEER W. D. WEAVER, U. S. NAVY.

The apparatus, a description of which follows, was devised to carry into effect Engineer-in-Chief Melville's method of making speed trials.

An ordinary chronograph was first suggested, but the delicate nature of such instruments and the great expense for one suitable for use aboard ships, made its adoption impracticable. While making inquiries about forms of chronographs, it was learned that a number of Morse registers had been fitted with two pens for use as chronographs in college laboratories, and as a result the present apparatus was devised.



FIGS. 1 AND 2.

While in principle a Morse register, it differs in being more carefully constructed; in having a governing attachment, by means of which the speed of the paper may be varied; in having five pens instead of two, and in the method by which motion is given to the pens by the magnet armatures.

The essential principles of the apparatus, which is shown in Fig. 1, are as follows:

By means of a clock train a paper tape is passed above the pens, on which, at each electrical contact, a mark is made by one of the latter, as shown in Fig. 2.

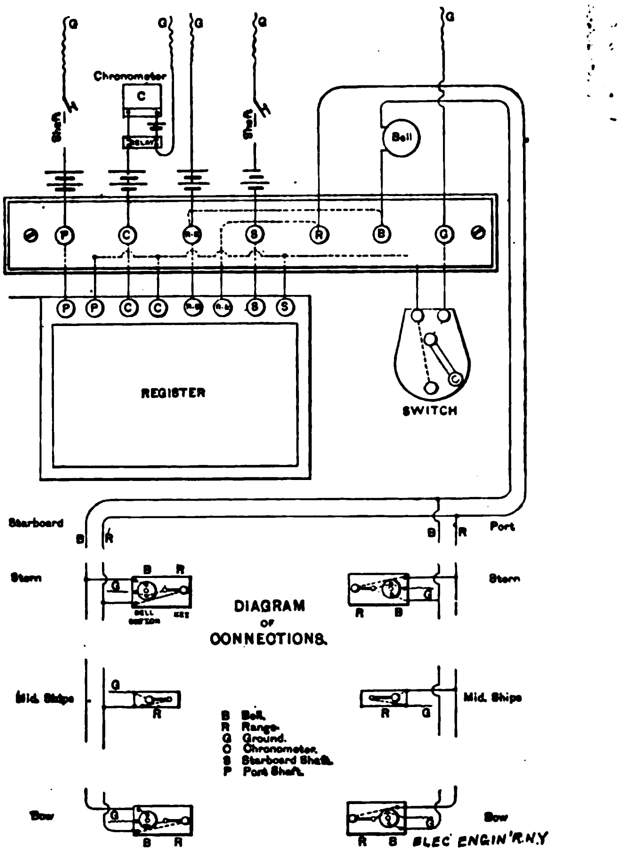


FIG. 3.

To an arbor of the train is attached one of three inertia governors, by means of which the speed at which the tape is paid out can be regulated. One of these permits a motion of one-half inch per second, another of one inch, and a third of one and one-half inch per second; running free, the tape has a speed of about two and one-half inches per second.

In order that the speed may be as regular as possible, a Geneva stop is connected to the barrel of the main spring, so that only that part of its length may be utilized in which the elastic force is approximately constant.

The five pens are actuated by four magnets. To one of the magnets is led the interrupted current of an electric chronometer, to two others the currents established by contacts on the port and starboard shafts, respectively, and through the fourth a momentary current is passed at the instant of arriving on and leaving the measured mile course. To the latter armature are connected two pens which mark on the two margins of the tape, thus permitting a datum line to be drawn from which are measured the fractional parts of time and revolutions.

The instrument will run out 125 feet of tape with very little variation of speed. This, with the inch-per-second governor, corresponds to a time of 24 minutes. It should be remembered that the requirement of the clockwork is that the speed of the tape shall not appreciably vary during each period of a second, and that variation with this instrument is infinitesimal.

Owing to the powerful spring and few arbors in the train the probability of the instrument becoming deranged is small. During a large number of experiments, some of them purposely made very trying, no hitch whatever occurred.

An essential feature is the "piano action" motion of the pens. Through this the time of contact with the tape is infinitesimal, thereby avoiding friction against the tape at a critical point—a defect of the two-pen chronograph.

As only intervals of time, revolutions, and space were required, not the absolute time of passing a range mark or of a given revolution, the pens, for simplicity, are made to mark at a "make" contact; and as the chronometer marks at a "break" contact, a relay must be interposed between it and the register.

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[1] *Journal of the Amer. Soc. of Naval Engineers.*

Should it be considered that the accuracy within the limits of measurement may be improved by using a "break" contact, it will only be necessary to change the windings of magnets and slightly change the motion to effect this. It is very doubtful, however, if this change would measurably, if at all, increase the accuracy.

For trial trips it is proposed that there shall be three range observers, one at the bow, another amidships, and a third on the poop. As the ship enters on, or leaves, the range course, the observer will touch a key and a record will be made on the tape; in addition, there will be a bell button at the bow and stern to notify, from twenty to thirty seconds before the ship enters the course, the one in charge of the instrument that he may set it in motion and switch on the battery.

The diagram of connections, Fig. 3, shows the manner of setting up the register and will make clear the method of operation.

The tape may be measured to hundredths of a second, and, with a shaft making one hundred and twenty revolutions per minute, fiftieths of a revolution. The marks on the *fac-simile* of record are longer and heavier than on an actual record, and the illustration of the register is inaccurate in several respects, having been made by the engraver from a photograph without proper supervision and correction.

With the instrument made for the Bureau of Steam Engineering were furnished special keyboards, contact brushes, connection board, etc., and drawings and specifications; so that the apparatus could be set up complete for use in a couple of hours after arriving aboard ship, or in the time required for wiring.

TRANSFORMER DISTRIBUTION.[1]

BY J. SWINBURNE.

THE distribution of electrical power by means of alternating-current transformers can hardly be considered to have reached its final state, and though it may be somewhat difficult to say what system will be in general use ten years hence, there is little doubt that present practice will be largely superseded.

The method now in vogue is simple: It consists of running several independent dynamos, each with its own engine; each dynamo supplies a few high-pressure mains, which branch off, and supply transformers placed in the houses, or wherever light is required. This system, admirable for country towns or straggling villages, is hardly likely to be permanent anywhere else. It has many disadvantages. Except that all the dynamos and engines are in one building, it is nothing more than a collection of little independent installations. In cases of a breakdown, there is a stoppage till new arrangements can be made at the station. In addition to this, great lengths of high-pressure conductor are required, and this leaves openings for breaking down of insulation. The introduction of high pressures in private houses is dangerous if not well managed, and is in any case expensive, demanding compliance with all sorts of regulations, rendered necessary for the security of the public. The greatest drawback to the present system, however, lies in the waste of power in the transformers themselves.

It must be borne in mind that in spite of the drawbacks of the present system of putting transformers in houses, it may be, and probably has been, advisable for electric light companies to begin on that system, even in such places as London; but I do not think such an arrangement will pay in the long run, and a time will arrive when the mains will have to be changed and a low-pressure supply system substituted.

PARALLEL RUNNING ACCORDING TO ORTHODOX HYPOTHESIS.

To begin at the beginning of my somewhat extensive subject, the first question is that of running machines in parallel. There are few matters of greater importance to engineers, and few on which opinions differ so widely. One says that machines will not run in parallel unless they have large self-induction; another that it is necessary to have iron in the armatures; another that they will only run together if they have no self-induction, or as little as possible. Others say that there is no difficulty in running them in parallel. No engineer who employs direct currents denies the advantages of running the machines in parallel; if independent running is advisable in alternate systems, it is equally advantageous in the case of direct currents, and direct-current stations should have separate circuits for each little district, each district being run by one dynamo. I do not think, therefore, independent running is advisable.

It is necessary first to get a clear idea of what is required for parallel running. It is not exactly the same as the case of alternating motors, neither is it the same as two machines of equal pressure coupled in parallel by themselves.. If all the machines are coupled to main conductors, we may consider them one at a time, and take each dynamo as coupled to a system whose pressure and variations of pressure are independent of it. Suppose the effective pressure to be 2,000 volts, for example; we have to consider a pair of mains with 2,000 volts and we have to couple on a dynamo to add so many amperes to it. Such a machine must not be excited to give 2,000 volts on no load, being then thrown into circuit with full steam turned on immediately afterwards. It should be excited to give somewhere about half load with 2,000 volts at the terminals, and should then be thrown in. Steam can then be turned on, and the excitation raised to its normal value. The machine should be so designed that any excessive power that the engine may give shall not only not throw the machine out of step, but shall not increase the armature current to such an extent as to damage the insulation by excessive heating.

The power absorbed by a dynamo working on a parallel system is

$$P = \frac{B^2\,r}{2\,i^2} - \frac{A\,B\,r}{2\,i^2}\cos 2\,\pi\,n\,\tau + \frac{A\,B\,L}{2\,i^2}\sin 2\,\pi\,n\,\tau,$$

where A is the maximum station electromotive force—that is to say, the station pressure is $A \sin 2\,\pi\,n\,t$, — B is the maximum "impressed" electromotive force in the armature, r is the armature resistance, i the impedance of the machine, and τ the angle of lead. This equation is taken from a paper by Dr. Hopkinson. When the dynamo is doing its proper share—that is to say, under normal conditions—

$$B = I\,c,$$

where I is the impedance of the whole circuit when the machine is isolated, and working at full load on an external resistance, and c is the maximum value of the current. To find how much the driving power may increase for a small increase of current, we may differentiate with respect to c, and then find the value of L which makes the result a maximum.

$$c = \sqrt{\frac{A^2 + B^2 - 2\,A\,B\cos 2\,\pi\,n\,\tau}{i^2}}.$$

$$\text{Cos } 2\,\pi\,n\,\tau = \frac{A^2 + B^2 - i^2\,c^2}{2\,A\,B}.$$

So,

$$\frac{dP}{dc} = \frac{A\,B\,r}{2\,i^2}\cdot\frac{i^2\,c}{AB} + \frac{A\,B\,2\,\pi\,n\,L}{2\,i^2}\cdot\frac{d\sin 2\,\pi\,n\,\tau}{d\,2\,\pi\,n\,\tau}\cdot\frac{d\,2\,\pi\,n\,\tau}{d\cos 2\,\pi\,n\,\tau}\cdot\frac{d\cos 2\,\pi\,n\,\tau}{d\,c};$$

and in the case of a dynamo working on resistance, or on a station load when supplied with just its right share of power,

$$\cos 2\,\pi\,n\,\tau = \frac{A + r\,c}{B},$$

$$\text{and cosec } 2\,\pi\,n\,\tau = \frac{B}{L\,c}.$$

So,

$$\frac{d\,P}{d\,c} = \tfrac{1}{2}\,A + c\,r,$$

c being the maximum, not the effective, current. It will be observed that L has disappeared altogether.

This shows that for a very small increase of power the increase of current will be the same, whatever the self-induction of the machine may be. It would not matter if the machine had none. A machine with no self-induction would short-circuit the mains if the engine supplied too little power; in fact, at full load it would be giving its minimum possible output, and any attempt to diminish this would be disastrous.

Discussing the question of a very small increase is not exhaustive; an engine may supply a large proportion more than its share of power to one machine. For instance, suppose it supplies twice the normal power. Many engines could not give such an excessive power, but in others which have expansion gear controlled by a speed-governor, it is easy to get double power if the station is running at a slightly slower speed than that for which the governor is set. These matters are always made much clearer by taking practical examples and working them out. The great difficulty is to obtain accurate data. I should prefer to discuss such machines as those described in Mr. Mordey's paper read here a short time ago. Without wishing to say anything in disparagement of his excellent paper, I must point out that an account of experiments should contain full particulars of the machines on which the experiments were made. Such omissions are exceedingly common in electrical papers. Mr. Mordey has not given us the details of the field magnets, air space, armature coils or exciting coils; he has not even given us the currents in the different experiments. I have found similar omissions whenever I have tried to gain information from any of the numerous experiments which have been made on alternate machines in America. Mr.

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[1] Abstract of a paper read before the London Institution of Electrical Engineers.

Mordey does, however, say that about half the drop in his machines is due to resistance, and half to self-induction. The machines give an output of 2,000 volts and 20 amperes, and when fully excited give 2,200 volts at no load. This would correspond to a self-induction of 0.05 henry.

Suppose, first, that the self-induction were such that $2 \pi n L = r$; on increasing the power supply, the effective current increases evenly, and when the power supplied to the machine is doubled, the effective current is only about 44 amperes. It is necessary, however, that the machine should stand decrease of load, as well as increase, without injury. Keeping the same self-induction, let us decrease the load to zero with the full excitation on. The current gradually diminishes to just below 15 amperes, and then increases to just over 20 again. These figures are extremely troublesome to work out from Dr. Hopkinson's equations, as the angle is so small that an error in about the sixth place of decimals will vitiate the results.

Many people prefer diagrams such as those used in mathematical books when dealing with harmonic variations. Mr. Blakesley has applied these diagrams to the discussion of alternate dynamos and motors, and Messrs. Kapp, Fleming, and others have applied them too. The chief drawback is that it is not always easy to draw such figures to scale. They are generally drawn with the values taken at random, to give ideas of the principles involved. So far as I know, no scale diagram of this sort has ever been published. In the case of the 40,000-watt machine such diagrams can be applied; but with 100,000 machines, which will probably be the standard size, the diagrams are almost illegible.

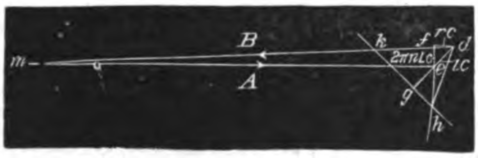


FIG. 1.

Fig. 1 is a diagram to scale. The lines are all rotating positively. The diagram is made as follows: The pressure in the mains, A, is drawn first. Instead of the maximum, it is simpler to draw the effective pressure—in this case 2,000 volts. From the end e, $2 \pi n L c$ is drawn at right angles to it to f; and then $r c$ from f, parallel to A; B is drawn to join the ends of A and $r c$, as shown. The lines are all pressures; but the instantaneous current is in step with the pressure $r c$ and with the pressure A, so that the power is proportional to B $r c \cos f d m$. I use the expression "in step" to mean co-phasally synchronised. Thus two machines may be running at the same speed without being in step; just as soldiers may take the same number of paces per minute without being in step.

To find the current at double load, produce $i c$ to g, so that

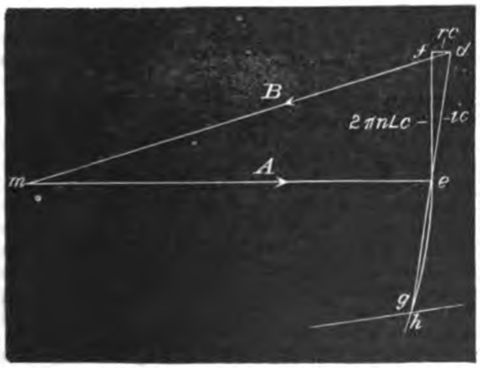


FIG. 2.

$d g = 2 i c$. Through g draw a straight line cutting B at k, at an angle, $g k d$, equal to the angle $d e f$. The line $g k$ is the locus of the end of the line representing the pressure spent over the resistance and self-induction of the armature with currents giving double load. It is unnecessary to go into the proof of this. With m as centre and A as radius, describe arc cutting $k g$ at h; join $d h$. Then the current at double load is to 20 amperes as $d h$ is to $d e$. In this case the double-load current is not much more than 40 amperes.

To find the current at half-load, bisect d e, and through point of bisection draw a straight line parallel to h k, and proceed as before. The no-load line, of course, passes through d.

Let us now assume the self-induction to be 0.05. The resulting diagram is shown in Fig. 2. The double-load current is almost exactly 40 amperes.

We thus find that according to the self-induction hypothesis the difficulty does not lie, as commonly supposed, in getting enough self-induction in the armature; the trouble is that there is generally too much. But in machines from 25,000 to 50,000 watts it is exceedingly difficult to make dynamos that will not run perfectly in parallel, so great is the permissible margin of self-induction. It must be carefully borne in mind that so far the armature has been supposed to have a constant coefficient of self-induction, and the pressures of current are assumed to vary harmonically.

The orthodox hypothesis thus tells us that with ordinary sizes of machines it is exceedingly difficult to design them so that they will not run in parallel. Either, therefore, all ordinary machines run perfectly in parallel, or the hypothesis is wrong.

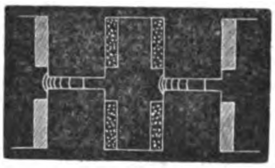


FIG. 3.

PARALLEL RUNNING ACCORDING TO ARMATURE REACTION THEORY.

Take the case of a machine like the Siemens, with coils passing between poles. If there is a continuous current in the armature, in some positions it will assist the field magnets, and in others it will to some extent weaken them, while in intermediate positions it has no effect on the magnets as a whole. In an alternate-current machine, though the armature current is alternating, relatively to the field magnets it is direct. If a series of instantaneous photographs of the armature current could be taken, each part of the air space would have its direct current.

If the pressure curve of such a machine were traced, and placed in the diagram of the poles, it would be as shown in Fig. 4. The positive direction of the current or pressure in the armature and field-magnet coils is shown by shading, the negative by dotting. If electricity flows in the armature when the sides of the coils are in the active fields, one side of the field between the poles is strengthened and the other weakened, as shown in Fig. 3. The field thus becomes stronger on one side. The curve of pressure thus gets displaced, as shown in Fig. 5.

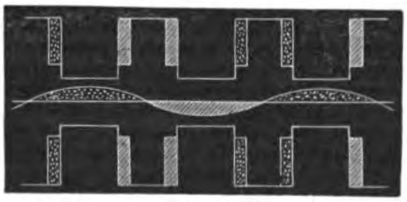


FIG. 4

It will be seen that each magnet is now exposed to the back induction due to the armature current. A circuit, a, taken round the field-magnet circuit is interlinked with the whole wave. The line integral is not changed if it is taken round any other circuit, so that the sides are the same distance apart as they are in a. A circuit taken as shown at b, however, includes only half a wave; so that from Fig. 5 both the cross and the back induction could be completely worked out.

The effect of the armature current, then, is first to make the current lag relatively to the position of the field magnets, and then to lessen the pressure as a whole. It thus resembles the effect of the insertion of artificial self-induction.

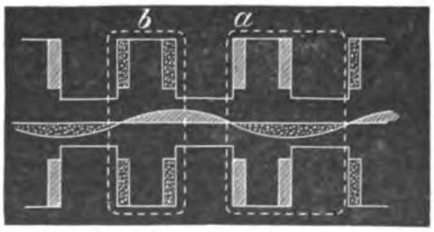


FIG. 5.

(*To be continued.*)

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER 150 *Broadway, New York city.*

PLANT EFFICIENCY WITH HEDGEHOG TRANSFORMERS.

Mr. Swinburne's communication on plant efficiency of transformers, published in your issue of March 4, seems to me to require an answer. Neglecting so much of his communication as refers to personal matters, the first point raised by Mr. Swinburne is that the leakage current passing through his transformers when the secondary circuit is open is but one-third of the maximum value of the primary current at full load. In a communication received from Mr. Swinburne a few days after the publishing of my article, Mr. Swinburne states that the leakage current in his transformer is *about* 50 per cent. Allowing that this "*about*" 50 per cent. is correct, the comparative leakage currents in the open and closed types of transformers is approximately 10 to 1; that is to say, the leakage current in transformers of Mr. Swinburne's make is approximately ten times that ordinarily found in closed circuited transformers; and, as a consequence, some source of supply must be attained to furnish at all times ten (10) times as much current for the hedgehog transformer as is required for the closed circuit type. There should be no misunderstanding about this.

The second point raised by Mr. Swinburne that requires attention relates to the comparative hysteresis losses found in the closed circuit and hedgehog types. Mr. Swinburne says that at no load the loss in iron in hedgehog transformers capable of supplying 10,000 lights is 5,000 watts. He fails to state what size transformers are included in this estimate. If only this loss is attained when transformers of small capacity (from 20 to 40 light size) are used, then such transformers will not keep the potential upon the secondary circuit sufficiently constant for practical use. It is generally recognized in this country that the variation of potential upon the secondary circuit of small transformers must not exceed two (2) per cent.

This all goes to show that it is idle to compare the open and closed types of transformers, unless the comparison is made upon apparatus of similar size, and designed to work within fixed limits of regulation. The ingenious methods resorted to by Mr. Swinburne to make up the necessary current to supply his transformers, are, of course, a sort of solution of that difficulty. It is possible to arrange a motor-generator in a station to supply the false currents required, when no, or few, lights are burning. If I remember correctly, Mr. Swinburne has stated lately that he has been enabled to provide a condenser arrangement, such as suggested in his communication, which will be efficient and free from the liability of breaking down.

As to the remainder of Mr. Swinburne's communication, I am not aware that there is any monopoly on closed circuited transformers in this country, but Mr. Swinburne is probably not quite posted on the development of the closed circuited transformer. I have constructed a number of large transformers, which on test show an efficiency of 97.2 per cent., while the fall of potential upon the secondary circuit was but six-tenths of one (1) per cent. between full load and no load. These encouraging results lead me to believe that we shall still further advance in transformer development.

Mr. Swinburne closes with the remark that the advocates of closed circuited transformers should do him the justice to acknowledge that the value of their work is due to him because he read a paper in 1888, before the British Association on transformers. I am sure that all electrical engineers in the country will acknowledge gratefully, not only this communication of Mr. Swinburne's but all others that have emanated from his pen. We had generally supposed in this country that Prof. Ewing's work on hysteresis loss was fundamental, and so, before Mr. Swinburne's valuable paper appeared, numerous electricians in this country had made use of Prof. Ewing's work. It now appears that we should have waited until after the appearance of Mr. Swinburne's paper.

WILLIAM STANLEY, JR.

PITTSFIELD, MASS.

UNSUSPECTED ANTIQUITY OF WHEATSTONE AND HIS TELEPHONE.

Telephones are of greater antiquity, says the *Chicago Evening Post*, than is generally supposed. Wheatstone describes his "telephone" in 1721, and in 1854 Ch. Bourseul said: "It is certain that in a more or less distant future speech will be transmitted by electricity."

European Correspondence.

LONDON.

Signaling on Railways.—National Telephone Co.

CALLING at Basinghall street a few days ago, I was shown Pere's electric railway signaling system, the inventors of which claim that it is calculated to afford immunity from almost every ordinary form of railway accident. I was supplied with the following statement which amply describes the apparatus. It consists of three conductors, one of which lies between the rails, and the other two on either side of it, on each track, the two lateral conductors being either within or outside the rails. The central conductor is continuous, while the lateral ones are interrupted, the interruption on one side of the line being opposite the central portion of the other lateral conductor, and the lengths of the conductors, which are calculated to form blocks for signaling purposes, being such as the amount and complexity of the traffic may require. The conductors are bars of rigid metal, copper being used in the model; but it is said that soft iron will answer every purpose in actual traffic. They are kept in electrical contact with the engine, or, if desired, with any portion of the rolling stock, by metallic brushes descending from the latter and resting upon the conductors but so arranged and placed as to be subjected to the minimum of wear from friction. The forward end of each lateral conductor, at each point of interruption, is connected by an underground wire with the hinder end of the conductor on the other side at the next interruption. The electric force is supplied by a battery carried on each engine, and, as only a small amount of power is required, the inventors speak of ten Leclanché elements as being sufficient for the purpose. It would be impossible, without the aid of diagrams, to convey a clear notion of the manner in which the actual and possible circuits are arranged; but the general effect is that each engine is able to ring a call-bell at the station in front of it or at the one behind it, or at both, and, having thus obtained attention, is able to open telephonic communication with them. When a traveling engine receives a current from another, this may be caused either to ring a bell or to release a weight the fall of which may put on a brake, so that any alarm given to a driver may either inform him of some danger or may automatically arrest his course. If trains are running in opposite directions on the same line of rails, and equally if one train is overtaking another on the same line, or if approaching a stationary train on the same line, as happened at the recent accident near Taunton, so soon as they are within a distance of each other, which is governed by the distance apart of the interruptions on the lateral conductors, a bell is rung on each engine, or, as just said, things may be so arranged that a brake is applied. In either case, the two drivers at once obtain the power of telephonic communication with each other. The rolling stock may be fitted with brushes which do not usually touch the conductors, but which are suffered to fall upon them by any severance of the train: and in this way the presence of a detached carriage may be instantly made known not only to approaching trains, but also at both the adjacent stations. Approaching trains could be at once warned by plate layers of the presence of any obstacle on the line; and would be warned automatically if the obstacle were a conductor of electricity, so that it would serve, when lying across the conductors, to short circuit the current. Plate layers would also be provided with portable telephones, which they could connect at any point for the purpose of communicating the intelligence of any accident or impediment. A bell might be rung upon the engine, or a brake applied, either when approaching points which were wrongly set or on running into a dead siding. Drivers might be prevented from permitting undue delay in the application of the brake on approaching a station or at any other point on the line, and a bell might be rung continuously at every level crossing when a train had come within a certain distance of it, and until it had passed by. It is said on the part of the inventors that the fitting the apparatus to the railway, exclusive of its application to the rolling stock, would cost only about £150 a mile, and that the insulation of the conductors will be easily maintained and easily tested. The system, if successfully in operation, would greatly facilitate the conveyance of large bodies of troops by railway, in consequence of permitting a free communication between successive trains, and on this account I understand the German military authorities are about to test its applicability in actual working.

A meeting of the Western Counties' shareholders is to be held next week for the purpose of passing a resolution to sell the concern to the National Company. The Western Company is a branch of the larger company worked by license. Such was the enterprise and zeal of the local managers that the offspring bid fair to run the parent a hard race. As an indication however that the administration of the National Company does not meet the approval of all the subscribers, it may be mentioned that at a private meeting of the Border subscribers consisting of about 200, it was unanimously agreed to give the company notice to remove telephones and poles. I believe that the cause of the disagreement is the refusal of the National Company to lower their charges.

M. S.

LONDON, March 11, 1891.

Literature.

Sixth Annual Report of the Board of Gas and Electric Light Commissioners of the Commonwealth of Massachusetts. January, 1891. (Pub. Doc. No. 35.) Boston, 1891.

Twenty Second Annual Report of the Board of Railroad Commissioners, January, 1891. (Pub. Doc. No. 14.) Boston, 1891.

The venerable commonwealth of Massachusetts has always adhered to the highly commendable practice, which might be followed with obvious advantage by many of her sister states, of appointing as members of her board of commissioners of public works, reputable citizens of capacity and intelligence, rather than rumsellers and ward politicians; and, as a consequence, many of the reports which issue from her state printing office have a positive and practical value, and abundantly repay critical examination. In this respect, it is not too much to say that the Massachusetts public documents need not, as a rule, fear comparison with the parliamentary bluebooks of our transatlantic cousins, which, by the way, is no inconsiderable praise.

In a general review of the condition and prospects of the illuminating companies, both gas and electric, the commissioners make the following observation:

> The amount of capital stock is usually of vital consequence to the consumers and patrons of a company. It should be kept at the lowest practicable point, as the best guarantee for cheap light, as well as for reasonable dividends. Some of the companies, managed by men of a speculative turn of mind, manifest a desire that every expenditure for construction or improvement, or rise in the market value of plants, shall be represented by interest-bearing dividend scrip, or by new shares of stock, on which it is proposed to pay the usual dividends, at least until the stock is palmed upon innocent buyers. To avoid disappointment and loss by such stockholders, whenever the law shall be applied regulating the price of light, which intelligent consumers ask to have fixed on the basis of actual and necessary cost and reasonable dividends, it is suggested that the issue of such scrip be prohibited, and that the prior assent of the board to a new issue of stock be prohibited by statute.

In view of frequent inquiries received by the board in reference to the vexed question of the actual candle-power of arc lights, authority is asked to employ an expert at discretion to make tests when necessary. The board, although authorized by statute to do so, has not deemed it expedient to attempt to regulate either the prices or conditions of the electric light supply, except in one instance. The Boston Edison Company objected to supplying at night a certain block of buildings equipped with lamps and fittings of a different make, and which depended upon its own plant for its current during the day. Under the authority of the statute of 1886, an order was made in this case by the board directing the Edison Company to supply the petitioners with current, which appears to have been complied with, without further objection.

Five cases of personal injury from electric currents were reported during the year, three of which were fatal. They were all caused by a 1,000-volt alternating current, and occurred in each case by the careless handling of wires. The statistics given in the report are interesting and instructive. The increase in the number of local companies during the year past, as might have been expected, is not great, but the aggregate capacity of the existing plants is being rapidly enlarged. There are now 73 chartered gas companies operating in the state, of which 28 are also supplying electricity. The number of electric companies is 111, an increase of 11 from last year. The receipts of the gas companies, notwithstanding the competition of the electric light, continue to show a steady increase in the sales by meter, though, as was the case the preceding year, the receipts from street lighting show a steady diminution, the figures being in round numbers, $327,000, as against $353,000 in 1889.

The aggregate liabilities of the electric companies as compiled from the figures given in the report, together with some other statistics of interest for the year ending June 30, 1890, are given below:

Aggregate capital of the 61 electric companies (not including gas companies supplying electricity)	$6,452,025.00
Total bonded and floating debt	2,102,944.80
Aggregate liabilities	$8,554,969.80
Receipts:	
For light and power	$1,908,394.00
From other sources	12,308.05
Total receipts	$1,920,702.05
Expenses:	
For manufacture	$ 752,881.18
For distribution	281,046.33
For office expenses and management	116,350.92
For taxes	67,620.91
For miscellaneous	122,965.26
	$1,340,814.60
Leaving a balance of	579,887.45
Deduct net earnings of electric departments of gas companies	110,871.40
Net earnings of electric companies	$469,016.05

	1889.	1890.
Total number of dynamos	368	578
Motors:		
On arc circuits	111	100
Incandescent circuits	379	578
Power circuits	48	128
Total motors	538	806
Commercial incandescent lamps	72,419	118,521

Of the 100 electric companies reporting, 22 have paid dividends during the year ending June 30, 1890, varying from 2½ per cent. by the Boston Edison Co. to 10 per cent. by one of the two companies in Pittsfield (a very small company by the way). The average rate of dividend paid is 4.86 per cent. The total amount paid in dividends during the year was $154,708, which is equal to only about 2.4 per cent. on the aggregate capital stock of all the companies in the state. This total net earnings of all the electric companies as reported, is equal to 5.48 per cent. on their aggregate liabilities.

Upon the fairly probable assumption that actual number of lamp hours is 12 per cent. of the maximum, the light given by the 118,521 commercial incandescent lamps during the year would be equivalent in round numbers to 628,000,000 feet of gas. This is only about three times as much gas as was made by the Lowell company alone during the year, and shows conclusively that the field of domestic electric lighting in Massachusetts is even yet far from being fully occupied.

Much other material of value might be gathered from this report if one had the time and patience to wade through the wilderness of figures, and foot up the tables given. In commenting upon the report of last year, we found occasion to criticise the omission of these summaries; a repetition of which negligence, in an official report of this character, is little less than unpardonable.

No such criticism can be made upon the report of the railroad commissioners, which, as is always the case, is a model of what an official report should be. All necessary information is given in a concise and convenient form, while the mass of useless verbiage too often forming the staple of such publications is conspicuous by its absence.

In the report of last year, attention was directed by the board to the necessity of regulating the speed of electric cars, and of equipping them with more efficient brakes. This warning has been justified by the increased number of accidents which are reported as having occurred during the past year. The result of a series of brake-tests, made under the direction of the board, resulted in the enactment by the legislature of a statute requiring street railway companies operating with other than horse-power, to equip their cars with such guards or fenders as the board may direct. The whole subject was then exhaustively investigated, and the results of the experiments made are given in an appendix of 38 pages, with numerous illustrations, containing the report of Professor G. F. Swain, the bridge engineer of the board. The result of his investigations was to demonstrate that it is not possible to devise an efficient form of fender applicable to four wheeled cars, when traveling at a high rate of speed, say seven miles per hour or over, on account of the vertical oscillation or "pitching" of the car. With double-truck cars, no especial difficulty exists. The statistics of the West End Company, of Boston, show that when computed on a basis of mileage, there have been twice as many accidents from electric as from horse cars.

The statistics of the electric railways of Massachusetts for the year ending September 30, 1890, are briefly as follows:—

Number of companies having electric lines in operation	17
Overhead trolley system, total miles	157.77
Storage battery system, total miles	3.09
Total miles electric railway in state	160.86
Number of companies having electric lines under construction	7
Overhead trolley system, total miles	28.45
Storage battery system, total miles	6

The maximum average running speed of the Boston and Revere and of the West End lines, when unobstructed by horse cars on the same track, is given as 12 miles per hour.

The report shows that the total number of trespassers on the tracks of the steam railroads of the state who were killed or injured during the year was 199, but it is probable that the newspapers have devoted more space to the reports of the three unfortunates who were killed by electric currents than to the whole number killed by the railroads.

The following figures relating to the operations of the West End Company, of Boston, are of interest:—

Receipts from passengers	$5,678,390.07
Receipts from other sources	101,592.50
Total receipts	5,780,082.57
Total expenses of all kinds	4,468,368.75
Percentage expenses to earnings	.77
Number of cars	2,031
Total length of road including sidings (miles)	239.45
Total miles run	17,665,860
Total number of passengers carried	114,853,081
Total number of employés	4,148
Gross income per mile run	$0.3272
Net income per mile run	$0.0742

Full returns are given of the results of operations of all the street railways, but as none of the exclusively electric lines have been running long enough to enable deductions of value to be made from an analysis of the returns, it is scarcely worth while to undertake it. The most important of the street systems are still in process of changing from horse or steam to electric power, which renders it difficult to get at trustworthy figures from their present returns. In future years, however, the Massachusetts reports cannot fail to be, in this respect, of the greatest value.

Reports of Companies.

AMERICAN BELL TELEPHONE CO.

The annual meeting of the Bell Telephone Company occurs early this week. If, as expected, the earnings of the company show the usual annual gains over the previous year, the report for 1890 will show net earnings of about $2,900,000, or about 23.2 per cent. on $12,500,000 capital stock.

The instrument output of the Bell Telephone Company for the month ending March 20, and for the three months of the company's fiscal year, is reported to-day, in comparison with last year, as below:

Month ending March 20.	1891.	1890.	Inc.
Gross	5,717	5,179	538
Returned	3,167	1,648	1,519
Net	2,550	3,531	†981
Since Dec. 21.	1891.	1890	Inc.
Gross	15.954	12,819	3,135
Returned	9,561	6,150	3,411
Net	6,393	6,669	†276

†Decrease.

COMMERCIAL CABLE COMPANY.

The following officers have been elected for the ensuing year by the new board of directors of the Commercial Cable Co.: J. W. Mackay, president; G. G. Ward, C. R. Hosmer and A. B. Chandler, vice president; E. C. Platt, treasurer and J. O. Stevens, secretary.

THE ELECTRIC MANUFACTURING AND GAS ENGINE CO.

The above company has been formed at Greenbush, N. Y., with a capital stock of $75,000. Its object is to manufacture gas and other engines and accessories thereto, and electrical apparatus of various kinds. The trustees are: E. N. McKinney, of Albany; G. H. Ennis, of Troy; R. J. Pratt and J. H. Pratt, of East Greenbush, and A. Rollanson, of England.

STOCKS AND BONDS.

HANNIBAL, MO., refuses to sell her 5 per cent. 50-year electric light bonds for less than par, and the town remains insufficiently lighted.

BOSTON, MASS.—The American Bell Telephone Company holds its annual meeting in room 21 of its new building at No. 125 Milk street, March 31, the books being closed March 27, to reopen April 11.

BROOKLYN, N. Y.—The stockholders of the Atlantic Avenue Railroad, of Brooklyn, have voted to increase the capital stock from $1,000,000 to $2,000,000. The money is to be used in equipping the roads with electricity as a motive power as soon as the franchise is granted. All of the Brooklyn surface roads are preparing to substitute electricity for horse power.

TOLEDO, O.—The Toledo Electric Railway has added $200,000 to its capital stock.

WINTHROP, MINN.—The city of Winthrop has voted to issue bonds to the amount of $5,000 to be expended in waterworks and an electric plant.

ATTLEBOROUGH, MASS —The sale of the Attleborough street railway has been negotiated, it is understood, with private parties. This road has a capital stock of $60,000, and a debt of $50,000 5 per cent. bonds. It is some six miles long, runs to North Attleborough and Wrentham; is, to an extent, a competitor of the steam railroad; is operated by electricity, and is said to earn 10 per cent. on the stock and almost as much more surplus per year.

BOSTON, MASS.—The Erie Telephone directors have under consideration a proposition to sell all or a part of the company's 70 per cent. interest in the Southwestern Telegraph and Telephone Company for $700,000, from a Texas syndicate.

LAWRENCE, MASS.—The Merrimack Valley Street Railway Company have received permission to increase their capital stock from $80,000 to $250,000. The petition was presented in order to secure money for equipping the road with electricity. Plans have been drawn for a power station, and now that the money is ready work upon the electric road will soon be begun. The North Andover and Methuen line will be made ready first for electric cars and then the line to Andover will be built and equipped.

BUTTE, MONT.—One of the most important sales recorded in Butte for some time past is that of the Metropolitan Street Electric Railway to Eastern capitalists. The price paid was $150,000. It is reported that the new company have also been negotiating for the purchase of the Butte Street Railway Company's lines and rolling stock, with a view of consolidating the two lines.

ELECTIONS.

KANSAS CITY, MO.—At a recent meeting of the Gill-Alexander Electric Lock Company, the following officers were elected: Robert Gilham, president; W. W. Alexander, vice-president; M. C. Gilham, secretary and treasurer. The company has a capital stock of $800,000. Among the prominent local men who are stockholders in the company are: Ed. F. Swift, R. R. Conklin, S. M. Jarvis, H. P. Churchill, J. W. and F. K. Hoover and James Lillis.

NEW YORK CITY.—The United Telegram Company at a recent meeting added to the board of directors Messrs. Albert B. Chandler and John W. Mackay, Jr. Mr. Chandler also was elected president of the company. He is president of the Postal Telegraph Cable Company and vice-president of the New York Quotation Company, the last-named being owned and operated by the New York Stock Exchange.

DUNKIRK, N. Y.—The directors of the Dunkirk and Fredonia Rapid Transit Company have elected the following officers: President, Frank E. Shaw; vice-president, Byron Rathbun; secretary, Samuel J. Gifford; treasurer, W. T. Colman.

WAYNESBORO, PA.—The directors of the Waynesboro Electric Light Co. have elected the following officers: President, Daniel Hoover; secretary, D. H. Geiser; superintendent, J. F. Geiser. There is about $11,000 of the stock subscribed, and the balance of the $15,000 is going rapidly. There are some 80 shareholders in all.

YOUNGSTOWN, O.—The stockholders of the Youngstown Electric Street Railway have elected the following board of directors: James Parmelee, G. E. Herrick, Myron T. Herrick, W. H. Lawrence, H. M. Garlick, William Cornelius and Hal K. Taylor. The board organized and elected James Parmelee, of Cleveland, president, William Cornelius of this city vice-president, and Hal K. Taylor, secretary.

HAGERSTOWN, MD.—Daniel Hoover has resigned the presidency of the Waynesboro Electric Light Company and E. Elden has been elected to succeed him.

DIVIDENDS.

BOSTON, MASS.—The Edison Electric Illuminating Company, of Boston, has declared a semi-annual cash dividend of 3 per cent., payable April 1.

PROVIDENCE, R. I.—The Narragansett Electric Lighting Co. has declared a dividend of $1 per share, payable April 1.

THE EDISON GENERAL ELECTRIC Co. has declared its sixth quarterly dividend of 2 per cent.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of March 28, 1891, from New York, Boston and Washington; Pittsburgh, March 27.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80	Edison Gen. Elec. Co	102¼
American Tele. & Cable	81	Edison Gen. Co. Def'd	...
Centl. & So. Amer	145	Consol'd Elec. Lt. Co	....
Mexican	210	Edison Illu'g Co. N. Y	79
Com. Cable Co	104¼	U. S. Elec. Lt. Co	30
Postal Tel. Cable	39	North Am. Phonograph	....

BOSTON.

	BID.		BID.
Thomson-Houston	43¼	Ft. Wayne Co	12⅝
" Pref'd	24⅝	Am. Bell	*194
" Series C	9¼	Erie	49
" " D	6¼	New England	50
" Int. Co	....	Mexican	.90 cts.
Thomson Welding Co	....	Trop. American	.75 cts.
Thomson Eu. Welding	55	Edison Phon'gph Doll	

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	167
Ches. & Pot. Telephone	58¼	Eck.&Sold. Home Elec. Ry.	56⅝
Amer. Graphophone	6	Georgetown & Tenallytown	60

PITTSBURGH.

	BID.
Westinghouse Electric and Manufacturing Co	11⅝

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 24, 1891.

Alarms and Signals :—

Fire-Alarm Signal Box, W. F. Singer, 448,684. Filed March 11, 1889

Provides visual and audible signals, and includes means for conveying the current around a break caused by any accident. In addition to a main circuit an auxiliary is provided ; a relay in each signal box automatically cuts in the auxiliary circuit upon rupture of the main circuit.

Electric Time Alarm, J. J. Gallagher, 448,712. Filed Nov. 28, 1890.

An electro-magnetic alarm clock.

The following three patents were omitted from our list of patents issued March 17.

Signal Box, J. C. Wilson, 448,398. Filed May 17, 1887.

Comprises an endless band and a series of groups of signaling surfaces, each group arranged transversely thereon, and a contact pen to operate with any group of signaling surfaces.

Signal Box, J. C. Wilson, 448,399. Filed May 17, 1887.

Specially applicable for police signaling. The signaling surfaces are arranged upon a drum, each running longitudinally from end to end, and are traversed by a contact arm.

Signal Box, J. C. Wilson, 448,400.' Filed May 17, 1887.

Employs a rotatable contact pen with a series of signaling surfaces arranged on a carrier movable in a direction parallel with the axis of rotation of the contact pen to present one or another signaling surface.

Clocks :—

Independent Electric Clock, W. S. Scales, 448,998. Filed July 19, 1890.

Contains a regulating member for actuating the driving mechanism in case the armature of the electro-magnet fails.

Secondary Electric Clock, W. S. Scales, 448,999. Filed Oct. 20, 1890.

Mechanism and devices similar to those of No. 448,998 above, applied to a secondary clock.

Conductors, Conduits and Insulators :—

Water-Proof Combined Coupling and Cut-Out for Electric Circuits, F. Shlaudeman, 448,679. Filed Nov. 3, 1890.

Applicable to the use of interior conduits and shown applied to an incandescent lamp circuit.

Connector for Electric Wires, F. Shlaudeman, 448,680. Filed Nov. 3, 1890.

A conduit joint adapted to making a firm contact between conductors end to end.

Insulator for Electrical Conductors for Mines, F. A. Pocock, 448,838. Filed June 26, 1890.

Applicable to conduits for electrical conductors in the gangways of mines; employs flexible sheets which close an open side or slot of the conduit and permit the passage of a trolley or connector arm.

Electric Insulator, G. H. Graham and T. Gannane, 448,956. Filed Aug. 2, 1890.

An insulator of glass or similar material adapted to be screwed on a pin in the usual manner, and having a transverse groove in its upper end for receiving the wire ; it is provided on the outside with a threaded portion for receiving a ring ; the wire is held in place by loops from the ring.

Distribution :—

Electric Converter, M. G. Farmer, 448,614. Filed Oct. 11, 1890.

Employs laminated cores without the use of insulating material, in place of which very thin sheets of non-magnetic metal are substituted. Also divides the core elements transversely so that the core may be laminated not only in planes parallel to its axis but also in planes at right angles thereto.

Dynamos and Motors :—

Dynamo-Electric Machine, S. E. Nutting, 448,666. Filed May 13, 1890.

Designed to be capable of producing either a direct or an alternating current. One form described consists of two sets of field magnets, each having a hub and four cores projecting radially at right angles, and in the same plane, and having polar extensions from the outer ends of the cores of one set at right angles with their plane and connecting with the outer ends of the cores of the other set ; the armature is adapted to rotate within a circle partly enclosed by the polar extensions. In the armature core a series of thin strips of magnetic material is centrally mounted on the shaft, and a further series of such strips are centrally mounted on the shaft at right angles to and alternating with the first series of strips.

Electric Contact Device, F. A. Perret, 448,669. Filed June 28, 1890.

An improvement in carbon brushes for dynamos and motors adapted to provide greater surface contact between the brush and commutator. The brush holder is provided with a number of cylindrical chambers in which are loosely placed pencils of carbon which are held independently against the surface of the commutator by springs.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, C. J. Hirlimann, 448,798. Filed Nov. 26, 1890.

The porous vessel is made of moulded carbon and filled with manganese or other depolarizing agent, and has a concave bottom provided with perforations.

Clamp for Electric Battery Zincs, J. H. Leakin, 448,847. Filed Dec. 24, 1890.

A clamp designed to permit the removal of the zinc element without disturbing the connecting wire.

Electrolyte for Galvanic Batteries, J. J. Collins, 448,936. Filed Sept. 30, 1890.

Consists of an alkali, bichromate of potash or bichromate of soda, bluestone, an exciting acid, sulphur, and sulphate of mercury.

Lamps and Appurtenances :—

Cover for Incandescent Lamps, E. T. Mueller, 448,741. Filed Oct. 18, 1889.

A cover or shade formed of two similar halves with a connecting spring and catch.

Electric Lighting, R. M. Hunter, 448,782. Filed Dec. 30, 1890.

Employs, around an incandescent lamp connected in series, a shunt circuit, including a heating resistance enclosed in a receptacle which also contains an expansible substance adapted to be heated by an excessive current caused by breakage of the lamp.

Filament for Incandescent Electric Lamps, G. Erlwein and F. G. A. Heller, 448,914. Filed July 22, 1890.

A carbon core is provided with a hardly-fusible coating, consisting, essentially, of a compound of carbon and manganese.

Filament for Incandescent Electric Lamps, G. Erlwein, 448,915. Filed July 22, 1890.

Carbon filament is coated with nitride of silicon.

Filament for Incandescent Electric Lamps, G. Erlwein, 448,916. Filed Oct. 25, 1890.

Carbon filament is provided with a coating consisting of phosphorus, combined with a hardly-fusible metal ; as phosphorus and iron.

Filament for Incandescent Electric Lamps, F. G. A. Heller, 448,920. Filed July 22, 1890.

Consists of a small carbon rod with a covering of metallic chromium deposited thereon.

Electric Lighting System, E. H. Johnson, 449,041. Filed Jan. 10, 1884.

Devices and arrangements of circuits adapted to utilize electric lamps for displays of various kinds, as for ornamental and advertising purposes.

Measurement :—

Meter for Alternating Electric Currents, O. B. Shallenberger, 448,676. Filed March 13, 1890.

So constructed that the armature will require a certain value of current to set it in operation by reason of a dead-point formed in the armature. Such currents as may leak through the circuit when no work is being done will be insufficient to overcome the dead-point ; but the current required to operate lamps or other translating devices will overcome the dead-point and cause the meter to record.

Meter for Alternating Electric Currents, O. B. Shallenberger, 448,677. Filed March 13, 1890.

Designed so that it will commence to operate only when the current through the circuit in which it is connected exceeds the leakage of the circuit or of the converters. A short circuiting device, applied to the primary inducing coil, is automatically operated by the currents traversing the circuit.

Electrical Indicator, C. Wirt, 448,792. Filed May 2, 1887.

Improvements on the indicator patented to the same inventor July 20, 1886, No. 345,755. The improvements relate to the arrangement and construction of the adjustable resistance employed. The improved rheostat includes a turning drum having wire coils wound longitudinally upon it, bared for a portion of their length, transverse windings at the side of the bared portion to hold the coils in place, and a stationary contact bearing on the bared section of the coil.

Electric Meter, E. Thomson, 448,894. Filed Sept. 26, 1890.

Relates to meters for either continuous or alternating currents and to the class of meters known as "motor-meters." The commutator of the motor has both its moving and stationary conducting surfaces made of pure silver ; the commutator is made of the smallest practicable diameter.

Method of Measuring Alternating Electric Currents, O. B. Shallenberger, 449,001. Filed Dec. 26, 1888.

Claim 1 includes the method of measuring the currents consumed in doing useful work which consists in employing the leakage current of the circuit to overcome the inertia of the meter and in operating the meter by the current flowing in excess of such leakage current.

Meter for Alternating Electric Currents, O. B. Shallenberger, 449,002. Filed March 3, 1890.

Employs a thermostatic brake connected in circuit with the meter and operated by currents traversing it to release the meter when such currents exceed a predetermined value, thus preventing the operation of the meter by leakage currents when no work is being done.

Meter for Alternating Electric Currents. O. B. Shallenberger, 449,003. Filed March 13, 1890.

Claim 1 covers an arresting device for normally preventing the operation of the electric motor of the meter, and a releasing device brought into action by the currents traversing the motor when they exceed a predetermined value.

Medical and Surgical :—

Electric Belt, W. C. Fuller, 448,953. Filed Jan. 21, 1891.

A battery of a number of flat cells enclosed within a flexible casing adapted to be worn around the body.

Miscellaneous :—

Electric Switch, D. B. Turner, 448,698. Filed June 18, 1890.

Two elbow crank-levers have suitable contacts for their long ends, a reciprocating piece is connected with their short ends, and a lock has a movable part controlling the reciprocating piece.

Electric Heater for Dental Vulcanizers, J. O'Meara, 448,743. Filed Oct. 22, 1890.

In a dental vulcanizer having a steam generator, with a surrounding incombustible jacket, an electric heating coil is placed around the jacket.

Electric Heating Apparatus, M. W. Dewey, 448,879. Filed Jan. 20, 1890.

Employs a fibrous refractory material enveloping or covering the electric conductors and in continuous contact with them.

Electrical Protector, I. N Miller, 448,980. Filed Oct. 28, 1890.

A protector against excessive currents, in which a heat coil having an expansive core is employed to release, through the expansion at its core under the influence of an excessive current, the short arm of a lever for opening the circuit.

Electrical Heater, J. V. Capek, 449,035. Filed July 21, 1890.

For cooking. Details of construction and arrangement for applying electric heating to ovens and other cooking utensils.

Electrical Heater, J. V. Capek, 449,036. Filed July 21, 1890.

For cooking ; similar in purpose to No. 449,035 above.

Electric Rock-Drill, W. M. Schlesinger, 449,090. Filed Nov. 17, 1888.

Application of the electric motor to a rock-drilling machine ; includes special devices for disengaging the feeding mechanism from the drill-rod to admit of a quick return of the drill-rod independently of the feed mechanism.

Railways and Appliances :—

Electric Railway, R. M. Hunter, 448,653. Filed March 24, 1887.

Adapted to conduit systems employing sectional conductors and operating upon a series system.

Speed-Regulator for Electric Motors, S. H. Short, 448,681. Filed Oct. 10, 1890.

Particularly applicable to railway car motors. A speed branch in the form of a shunt on the field, with suitable means for cutting in and out, is used in connection with a series field, and in addition to an adjustable rheostat ; the cutting-in of the speed branch causes a fall of counter electromotive force at the armature brushes.

Adjustable Rheostat, S. H. Short, 448,682. Filed Nov. 15, 1890.

For motor cars. Consists in a number of insulating receptacles filled, between conducting end plates, with subdivided conducting or semi-conducting material, carbon powder, for example, and provided with contacts, connections and a traveling contact.

Support for Electric Line-Wires, H. C. Wirt, 448,703. Filed March 17, 1890.

A support and insulator adapted for suspending trolley wires from transverse supporting wires.

Overhead Crossing Appliance for Electric Railways, I. H. Farnham, 448,711. Filed Nov. 20, 1889.

A device for use at electric railway crossings where the overhead conductors are upon different levels; provides means for conducting the trolley traversing the upper conductor around the lower conductor without interrupting electrical connection between the trolley and the upper conductor.

Railway-Circuit for Signaling and Controlling Trains, F. E. Kinsman, 448,751. Filed June 11, 1890.

Claim 1 follows:

In an apparatus for controlling the movement of railway trains the combination, with a controlling magnet in a normally charged circuit, and means for interrupting such charged circuit to set the apparatus in "danger" condition, of a supplemental magnet or magnet coil for keeping the apparatus in "danger" condition, and a circuit therefor independent of that used in setting the apparatus, said circuit being through the rails and car wheels and axles of a section of road upon which the train moves, while the apparatus requires to remain in "danger" condition.

Electric Railway. T. A. Edison, 448,778. Filed Aug. 7, 1882.

Claim 1 follows:

In an electric railway, two main line conductors, in combination with a source of electrical energy therefor, and two branch line conductors connected to the main line conductors in permanent multiple arc connection.

Trolley for Electric Railways, R. Eickemeyer, 448,831. Filed July 19, 1890.

Adapted to a double trolley system employing two line wires one above the other; the grooved trolley wheels on each wire are connected together by a complex link having a central hinged joint, coupled to the two trolleys by other hinged joints, the axes of the wheels in both trolleys being parallel with the axes of the several hinged joints.

Protecting Motor Mechanism of Electric Cars, S. H. Short, 448,840. Filed Nov. 15, 1890.

Provides, with a car having an electric motor mounted on a driving axle and extending below the same, a protecting pan below the motor and curved in the direction of the travel of the car.

Electric Signaling Apparatus for Railways, E. D. Graff, 448,856. Filed Sept. 29, 1890.

Adapted to the "block system." Relates to means for signaling between two approaching trains on the same track; for signaling an approaching train when the train preceding it has stopped or for any reason has failed to pass out of a prescribed block; and to means by which the signaling devices are regulated or controlled so as to give notice to the engineers of approaching trains and to the engineer of a train which may come within a block or section of a track before a preceding train has passed out.

Lamp for Electric Railway Cars, C. G. Smith, 448,865. Filed Feb. 26, 1890.

Frame and reflector for electric or other lamps for attachment to the ceiling of a car.

Electric Street Car Driving-Gear, C. M. Conradson, 448,910. Filed Dec. 3, 1890.

Armature or motors journaled directly upon an inclined shaft carrying worm gear at each end meshing with gear wheels upon the axles of a car.

Locomotive Engine, R. Peacock & H. L. Lange, 448,927. Filed Sept. 20, 1890.

Method of connecting electric motors to the driving axles. Employs cranks and diagonally disposed connecting rods between the motor shaft or shafts and the axle or axles of the car, together with suitable guides.

Telegraphs:—

Telegraph, T. A. Edison, 448,779. Filed July 19, 1886.

Combines with two or more telegraph lines, each having ordinary Morse sets and induction sets, of one or more induction connections between such lines and one or more retarding or damming magnets to divert the inducting signals from portions of such lines. A "duplex" or "diplex," combining on one circuit ordinary Morse working and induction working.

Telephone Transmitter, T. Oeyan, 448,726. Filed Oct. 25, 1890.

Relates to the class of transmitters in which loose or granulated carbon is used for one of the electrodes, and consists in means for loosening the granulated carbon after it has become too compact from use without disarranging the apparatus or taking it apart.

Obituary.

MR. T. A. GAMEWELL.

Mr. T. A. Gamewell, one of the pioneers in the construction of telephone lines in the West, died at his residence at Denver, Col., on March 16th, of cancer of the stomach. Mr. Gamewell was superintendent of the construction department of the Colorado Telephone Company, and constructed the telephone line to Leadville over Mosquito Pass, a most difficult undertaking.

Appointments, Etc.

DANIEL E. SMITH, manager of the Portsmouth, Dover and Exeter (N. H.) Telephone Exchanges, has resigned his position and the vacancy has been filled by the appointment of William Todd, who has been located at Amesbury. He will have charge of Exeter and Dover. Edward Drew will have charge of the Portsmouth and York exchanges.

MR. WALTER N. SPERRY has been appointed general manager of the Birmingham division of the New England Telephone Company in addition to the Waterbury division. His assistant will be R. H. Gray, of Waterbury.

MR. T. J. EVANS has resumed the management of the Ottawa, Ill., Electric Street Railway Company and its affairs, which he turned over to the Thomson-Houston Company in Chicago, June 1, last.

Legal Notes.

KANSAS CITY, MO.—The Gill-Alexander Electric Lock Company have voted to retain Warner, Dean & Hagerman and Gates & Wallace to defend the injunction suit brought against it by the Secret Service and Combination Electric Lock Company, of New York city, for the possession of a one-half interest in the Gill patent.

UNITED LINES TELEGRAPH CO.—Henry Winthrop Gray has been appointed receiver of the United Lines Telegraph Co. by Judge Ingraham, of the New York Superior Court, in a foreclosure suit brought by the Farmers' Loan and Trust Co. His bond is fixed at $25,000.

INDIANAPOLIS, IND.—The Brush Electric Light Company have made application in the U. S. Court for an order restraining the Pettis Dry Goods Company from using the double carbon light.

Society and Club Notes.

NEW YORK ELECTRICAL SOCIETY.

The above society held a very large and successful meeting at the Electric Club, on March 27, when Mr. Joseph Wetzler gave an illustrated address on "The Electrical Progress of 1890." Mr. Wetzler had numerous models and drawings, and was assisted by many of the inventors, who came forward and described their own work. These gentlemen were: P. B. Delany, F. Jarvis Patten, Nikola Tesla, J. J. Carty, G. W. Walker, W. J. Jenks, W. E. Geyer, J. C. Chamberlain and Park Benjamin, who described Lieut. B. A. Fiske's range and position finders.

THE MILLIKEN POLES.

Messrs Milliken Bros., New York, report a large demand for their patent street railway and electric light poles, which they are now furnishing to almost every section of the country, including Canada. The large and increasing demand for these poles shows beyond doubt their superiority for the work for which they are designed. They have their large shops now completed with special machinery for turning out this class of work, and are able to fill orders promptly, either from stock on hand or at short notice. Among the recent orders which they have secured are the iron poles to be used for all the street railway work at Pittsfield, Mass. The street on which these poles are to be used is unusually wide, and consequently the strain on the poles is very great, and after a careful study the road found it to its advantage to use the Milliken pole. This firm has now out a very handsomely illustrated catalogue showing the different forms of poles which they make and their advantages, notice of which is given in another column. Parties desiring information on the use of poles for street railway or electric light work should write to the concern for information.

ISKE'S AUTOMATIC FIRE ALARM.

In THE ELECTRICAL ENGINEER, of March 11, appeared an illustrated article descriptive of the Iske automatic fire alarm, manufactured by Stoner, Myers & Company, of Lancaster, Pa. Since the appearance of this article the manufacturers have given a public test in Lancaster, under the direction of the mayor of that city. A match was applied to some "excelsior" in a building, with a view to reproducing the actual conditions of a fire, and within 15 seconds from the time the match was applied the automatic danger signal was given. The following item from the *Lancaster Daily Intelligencer*, of March 17, gives a terse and very satisfactory account of the test: "This morning a public trial of an automatic fire alarm which has been patented by Anthony Iske, was made by Boardman & Schaum, agents for the machine, at the works of Stoner, Myers & Co., on North Cherry street. Quite a crowd, including Mayor Clark, Chief Engineer Vondersmith, Chief of Police Borger, and a number of prominent business men witnessed the exhibition, which was a success in every way. The alarm is a small machine looking something like a clock. It can be fastened to the ceiling in any room and in case a fire breaks out there an alarm is sounded, the heat starting it. People who saw the alarm work were greatly pleased with it. The cost of putting them in is not large."

Stoner, Myers & Company are a new concern, and now occupy a three-story building in Lancaster, thoroughly equipped with machinery for the manufacture of their systems. They have already equipped a number of buildings with their alarms and are being pushed with orders for more. The capital of their company is $100,000 and a successful business doubtless awaits them.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

To advertise skillfully is part of the art of selling successfully.

THE CASE AUTOMATIC HIGH SPEED ENGINE.

There seems to be at the present time a decided and growing tendency toward the use of the self-contained, compact, single valve automatic cut-off type of engine. Its simple construction has made high speed possible, and the adoption of the best representatives of the class has been wide spread and general.

The accompanying illustrations, Figs. 1, and 2, represent the Case engine, the latest addition to the ranks, and a remarkable engine in many respects. It consists of a cylinder, having a length practically equal to its diameter, fitted into a cylindrical chamber, with its axis parallel to that of the main shaft. In this cylinder, at right angles to the axis, is bored the working cylinder of the engine, into which is fitted the piston, whose rod, working through a sleeve, is attached to the crank pin, as shown in Fig. 1. Advantage is taken of the vibrating motion of the horizontal cylinder for opening and closing the ports. The top of the working cylinder is left open through the containing case, the clearance being closed by the stationary wall of the chamber, so that when steam is admitted to the upper part of the cylinder, the pressure is downward upon the piston, and upward upon the stationary wall of the casing, and there is no tendency to press the vibrating cylinder downward. When the steam is admitted to the underside, however, there is a reaction downward upon the lower side of the horizontal cylinder, so that it is pushed against the lower wall of the chamber, with a force equal to the pull of the crank. This is counteracted by hollowing out a chamber in the lower side of the cylinder, as shown in Fig. 1, the area of which is equal to the cross sectional area of the working cylinder, minus that of the rod, and connecting this with the port, so that the pressure in this chamber is the same as that in the working chamber, thereby restoring the balance and preventing wear.

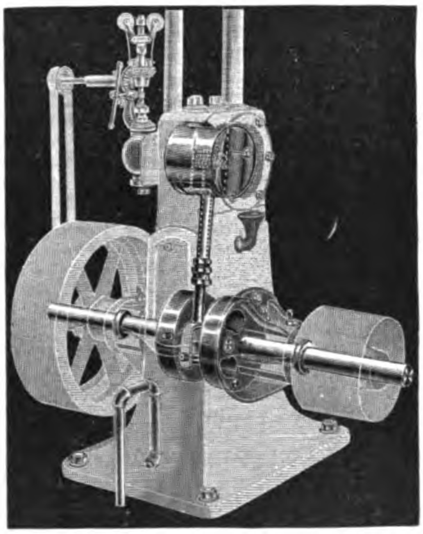


FIG. 1.—THE CASE AUTOMATIC ENGINE.

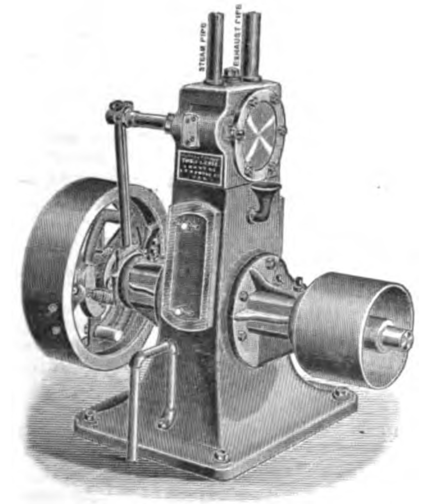


FIG. 2.—THE CASE AUTOMATIC ENGINE.

The frame of the engine is in the form of a closed trunk or casing, the bottom of which is filled with water, carrying on its surface a layer of oil. The crank dips into this at each revolution, and lubricates the moving parts. Concentric with the crank circle is placed a partition, separating the top layer of oil from the water and oil below, so that the whole mass is not churned up, and any sediment there may be is given an opportunity to settle.

A simple form of reversing motion is provided, when required. The engine is built in sizes of from 2 to 40 h. p., and in forms which allow it to be run vertically, as in Fig, 2, or bolted to an overhead floor beam, or, in fact, in almost any position. One of the smaller sizes was recently run at a speed of 2,000 revolutions per minute, and an 8 h. p. engine is now driving a dynamo in this city, which furnishes current for 100 incandescent lamps.

The general selling agency of this engine has been undertaken by Messrs. E. T. Copeland & Co., at 106 Liberty Street, New York City, who have also been appointed agents of the Ball Engine Co., of Erie, Pa., and will take charge of the New York business of that company, on May 6.

THE WERLINE MANUFACTURING COMPANY, LIMITED.

The above named concern, manufacturers of electrical and mechanical specialties, at Clark avenue, York, Pa., are getting into business shape very rapidly. They are now getting up a machine shop and foundry, with all the latest improved appliances necessary for the manufacture of their patented electrical apparatus. Among their novelties is an incandescent lamp socket, by means of which the light can be governed as with an ordinary gas burner key. They also have something in the switch line, which they consider hard to beat, making and breaking the circuit instantaneously. This form is made single pole, double pole, and three point, ranging in capacity from 5 amperes up. These will be mounted on porcelain bases and will be handsomely finished in bronze, oxidized silver, china, etc., to suit any style of house decoration. Their patent cut-out they also characterize as "somewhat of a 'hustler,'" and they already have orders for 5,000 or more from people to whom they have shown their model. It is neat, convenient and cheap. They are also perfecting a motor, which is expected to be ready by June 1st, next. There is likewise great activity in their gas lighting, annunciator and bell departments, and a fine line of each will be turned out. In short, they propose to make anything in the electrical specialty line that the trade demands. H. E. Werline is president; W. F. Wollin is vice-president; and George A. Barwitz, secretary and treasurer.

BERKSHIRE ELECTRIC COMPANY.

The Berkshire Electric Co., Pittsfield, Mass., have taken the contract to build the electric street railway in that city, from the Boston and Albany R. R. station to Pontoosuc Lake, a distance of between 3 and 4 miles. The cars will be equipped with the new slow speed Westinghouse motors and the Bemis trucks. Galvanized steel cable will be laid for ground wire, and feed wires of Shield brand wire will be run about two-thirds of the distance. Milliken iron poles will be used, and Mr. C. G. Tompkins, manager of the Berkshire Electric Co., expects to have the road in operation by June 1st. The Pittsfield Electric Co. will probably supply the power.

Mr. C. E. Merrill, the treasurer of the Railroad Co., is giving the matter the closest attention, and intends the road, when built, shall be one of the finest in the country.

The Berkshire Electric Co. have just finished the famous electric lighting plant for the residence of Geo. Westinghouse, Jr., Lenox, Mass., on which they have been engaged for the past 3 years. This plant is pronounced one of the largest and finest private plants in the country, consisting of over 1,300 lights.

The Berkshire Electric Co. are now engaged on several important plants in Massachusetts and New York. Their work takes a high rank for thoroughness and reliability.

ILLINOIS ELECTRIC MATERIAL CO.

The above Chicago concern will locate their headquarters on April 1, at 158 Fifth avenue, that city. They will open a store on the ground floor of the building and will do a retail business in the electric light and electric railway line. They will continue their large and growing wholesale business under more favorable conditions than ever, and will carry a large stock of Bishop india rubber wires, "Canvas Jacket" patent woven moisture-proof wire, and other leading and minor supplies.

THE WHELESS UNDERGROUND ELECTRIC CO.—THE CONDUIT AND HARMLESS OVERHEAD CONDUCTOR.

THE Wheless Underground Electric Company, Incorporated, of Tacoma, State of Washington, has recently come into possession of all of Mr. Malone Wheless' interests in his electric street railway inventions. These inventions cover both the conduit and overhead systems, of which a description was given some months ago in THE ELECTRICAL ENGINEER; when attention was called to the fact, that the Wheless system gave promise of solving the demand for underground electric street railways, as well as of furnishing a harmless overhead conductor for overhead lines.

The Wheless Underground Electric Company is now actively at work preparing to put in lines of street railway in several important cities; and has already commenced the construction of its first overhead line at Aberdeen, Wash. This road, when completed, will, it is claimed, be the first electric street railway ever built, of which the overhead conductor is perfectly harmless, and from which no injury can result to property or limb from the falling of the wires.

We note with particular interest the installation of this first road, and know further that it will be regarded with considerable interest by the general railway public. It is unnecessary to call to mind the accidents occurring from the falling of the electric railway wires; as well as another class of accidents due to the accidental "crossing" (by contact) of telegraph and telephone wires with overhead electric railway conductors. The Wheless system is designed to put at rest this constant cause of worry and trouble.

An experimental conduit road, built at Washington, D. C., last year under this system, has proven to be a complete success. This conduit system was tested thoroughly during the past winter, in heavy snow storms and ice, and in no instance was the working of the car interfered with.

The Wheless Underground Electric Company, as organized, has a paid up capital of $500,000, and has entered upon the construction of underground and overhead electric railways. It is the only company that is now prepared to put in an underground electric railway system which has been thoroughly tested and found to be successful.

In its overhead work, it has at once thrown itself into competition with the Edison, Thomson-Houston, and other companies putting in the overhead line.

The company is under a splendid and active management, and has already closed contracts for the construction of seven roads.

It has now three offices, one at Tacoma, Wash., a second, at Omaha, Neb., and another at Washington, D. C. The main office of the company is at Tacoma, Wash., under the management of General Manager and Vice-president, Mr. A. A. Honey, a gentleman fully posted in the details of electric street railway construction, and well known as being connected with some of the most successful enterprises on the Pacific coast.

The Omaha office is in charge of Mr. L. M. Rheem, a gentleman thoroughly posted in electric railway building. The Eastern office of the company, at Washington, is under the direction of Mr. Malone Wheless, the president of the company. Engineer H. S. Huson, of Tacoma, has resigned his position as principal assistant engineer of the Northern Pacific Railway, to take charge of the engineering department of the company, with headquarters at Tacoma, and has entered upon his duties. Under the supervision of his department all conduit and construction work will be carried forward. A branch office of the company will also be opened at New York at an early date.

In the Wheless system, the current is carried in a buried cable by the side of the track, and is fed from that automatically to the overhead or conduit trolley wire (according to whether the road is conduit or overhead). The trolley wire in either the overhead or conduit road is not a continuous conductor, but is cut in sections, insulated one from the other, and is at all times free from current except the section over which the car is passing, the current being in the power cable underground. This cable runs the entire distance of the road, and is a lead covered cable, which admits of its being laid under the surface of the street. There is no element of danger in the system, and a break in any section does not interfere with the operation of the rest of the road. If one of the sections of the overhead line should break and fall, the very fact of the parting of the wire cuts the circuit at the relay switch, and the line can be picked up with impunity and placed out of the way. The car can then be run to the next section (only a few hundred feet), where it can immediately get current and proceed on its way.

The above features apply equally to the conduit system. The trolley wire in the conduit is "dead" at all times, except the section which is in use under the car.

A striking feature of this system is the simple way in which a current of 500 volts is automatically switched from the main feed cable to any given section upon which the car is passing. This is effected by the use of a few storage cells carried on the car. These cells, when once put, in require no further attention, and simply operate a small relay attached to the pole in the overhead system, or fastened to a yoke in the underground or conduit system. This relay is placed at the juncture of the sections. The armature of the relay, when closed by the circuit of the storage cells (as the car runs on the section), simply bridges a feeder from the power cable to a short feeder from the trolley wire and lets the current pass into the trolley wire. As soon as the current passes from the trolley wire to the motor on the car, it cuts out the storage cell circuit; the armature of the relay being then held in contact by the main current which has been let in, and is flowing around one of the "poles" of the relay magnet.

The contact points of the relay are faced with carbon. This prevents any possibility of their sticking and thereby leaving the current in a section after the car has passed, it being impossible to fuse two carbon points together.

Electrically considered, this method is very simple, and Mr. Wheless has certainly shown a thorough comprehension of the character of electric railway currents, in the development of the "carbon switch." This switch is certainly a most beautiful and practical invention in its simplicity.

The reason why the *continuous* conductor cannot be used in the conduit, is the fact, that the "escape" in the line would be too great. The method under the Wheless system of carrying the current in a cable (where no escape can take place), and keeping the trolley wire in the conduit free from current at all times except in the given section, certainly avoids all "escape," and there should be no reason why this method of electric railway propulsion should not be successfully operated for underground electric railways.

It is needless for THE ELECTRICAL ENGINEER to call to the attention of the railway public the great demand for a competent and efficient underground electric railway system, and the new company certainly enters the field with our best wishes and congratulations.

The officers of the company are:—President, Malone Wheless, of Washington, D. C.; first vice president and general manager, A. A. Honey, Tacoma; second vice president, Charles M. Johnson, Tacoma; secretary, Andrew L. Horner, Tacoma; treasurer, C. S. Bridges, Tacoma; chief engineer, Herbert S. Huson, Tacoma. Three additional trustees, besides the officers named are: E. N. Ouimette and John B. Cromwell, Tacoma, and L. M. Rheem, of Omaha, Neb.

The counsel for the company are Judge Galusha Parsons, of Tacoma, and Mr. William H. Singleton, of Washington, D. C.

NEW CROCKER-WHEELER CATALOGUE.

Those who have not as yet perused the new catalogue of the Crocker-Wheeler Electric Motor Company, New York, will find within its covers, much of interest concerning electric motors generally and the Crocker-Wheeler perfected electric motors in particular. A handsome illustration of one of these motors printed in several colors makes an attractive frontispiece to the catalogue, which throughout shows evidence of much care and attention having been spent in its preparation and publication.

The text includes an interesting description of the construction of the Crocker-Wheeler motors, directions and suggestions for setting up and running them, and other valuable data regarding dimensions, horse power, cost, etc.

The construction and operation of a new indestructible resistance box made entirely of slate and iron, for starting, stopping and regulating their motors, is described in detail. The latter half of the catalogue is devoted to the smaller power motors, 1-6, 1-8 and 1-12 h. p., made by the company, and their numerous and useful applications. The text is well illustrated.

SOUND ALUMINUM CASTINGS POSSIBLE BY USING PLUMBAGO FACINGS.

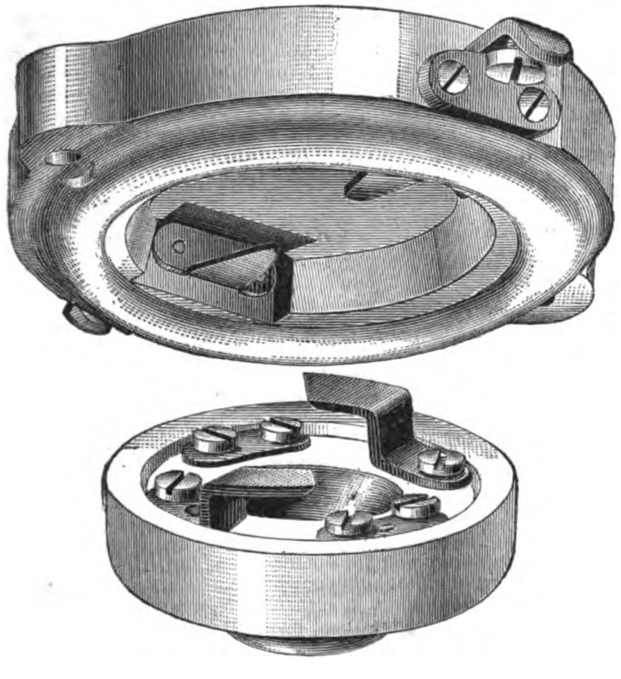
"Sound castings of aluminum can be obtained in dry sand moulds preferably lined with plumbago. The metal should be heated to a temperature very little above its melting point, and should be poured quickly. The shrinkage of the above metal is 17-64 inch to the foot (2.26 per cent. of the length of the mould)." The above statement is not only true as to aluminum, but of all metal castings. Actual sales of plumbago show that barrels of plumbago are now used in shops where pounds were formerly called for. Its use is becoming universal. The use of a plumbago facing absolutely guarantees to the casting a smooth surface and bright color. Caution is suggested when purchasing to obtain exactly the kind wanted for the different work. It can be said of plumbago as the Irishman said of whiskey, "None is bad, but some is better than others." One kind of plumbago is better applied by the shake-bag, and if the brush is used, another kind will prove better. One preparation of plumbago will "sleek," another will not. Another kind is more useful for light castings, another kind for heavier work.

Good plumbago will stand the heat and will neither burn or run before the molten metal. A wash of plumbago for cores, loam

work, and dry sand castings is indispensable. The Dixon Crucible Co., of Jersey City, N. J., have made a patient study of the subject, and being the only miners of plumbago who afterward prepare it for its many uses, they can give advice on the subject, not elsewhere obtainable. On application, they will send a little book free and post paid, that contains more information on the subject of plumbago than is elsewhere in print in any language.

THE CARTWRIGHT WATERPROOF CUT-OUT.

The accompanying illustration represents one of several new patterns of rosette, which include some novel and useful features. In the plain pattern Cartwright porcelain rosette and the ornamental pattern of the same, as will be seen, the brass connectors to which the wires are fastened have a slight projection from the base underneath the overhanging screw-head, opposite the point where the wire rests when it is clamped. The object of this projection is to prevent undue torsion of the screw when it is turned firmly down to clamp the wire. When there is no such support there is a tendency to throw the screw-head out of plumb and damage the connection, whereas, when the screw-head is equally supported on both sides, on one by the wire itself, and on the other by the projection, better results are obtained.



Cartwright Waterproof Cut-out.

In the Cartwright waterproof cut-out this feature in the connector is not only present, but special stress is laid upon the fact, that there are no screw-holes or metallic connections of any kind leading from the inside of the cut-out that might form contact with a damp ceiling.

These cut-outs are being placed upon the market by E. S. Greeley & Co., of this city.

A WESTINGHOUSE PLANT IN AUSTRALIA.

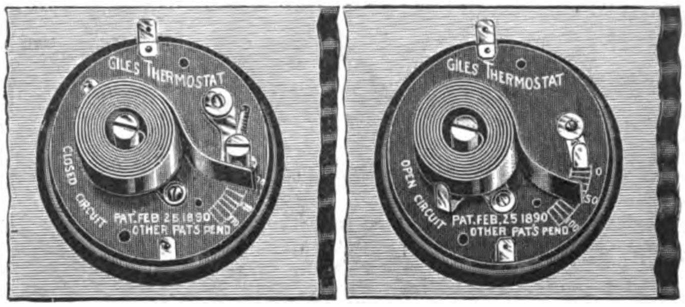
According to recent reports from Australia, the people of that country are now rapidly awakening to the advantages to be derived from the utilization of electric light and power.

A central station plant of electric lighting has just been completed at New Castle, which operates the Westinghouse system of alternating current central station apparatus.

The plant comprises arc and incandescent lamps. The dynamos are driven by Westinghouse compound engines. The plant is composed of Westinghouse alternating current dynamos and exciters. Steam for the electric plant is generated by Babcock and Wilcox boilers, working at 120 lbs. pressure per square inch, The switchboard is a very complete one, and by its means the light can be switched on and off at any given point in the town. The street lights are worked on two independent circuits and there are also two independent circuits for private lighting. The exciters and dynamo for the plant were manufactured by the Westinghouse Electric and Manufacturing Company, at Pittsburgh, Pa. The installation of the apparatus was superintended by an engineer of that company, who had been sent purposely to Australia. The plant gives great satisfaction to the public and city council, and is attracting the attention of other municipalities.

THE GILES AUTOMATIC THERMOSTATS.

The Giles thermostats are founded upon the well-known principle of difference in the expansion and contraction of metals. They are made from special grades of metals that, after severe tests, are found to produce the best results. They are free from the objections of liquid thermostats, in this, that they will not make contact when the floor or portion of the building where the thermostats are placed, is jarred. They are nicely finished, and all contact points are made of platinum. Fig. 1 represents a closed circuit thermostat, which is adjusted by means of a screw on the right. It is made to adjust from 70 degrees to 170 degrees, and has one-half inch movement in 100 degrees. Fig. 2 represents an open circuit thermostat, which is adjusted by means of a lever below the coil and has an adjustment of 100 degrees above the temperature of the room when placed in position and has one-half inch movement in 100 degrees. Fig. 3 is a side view of the thermostats. These thermostats are being placed on the market by the Central Electric Company, of Chicago.



Figs. 1 and 2.—Giles' Thermostat.

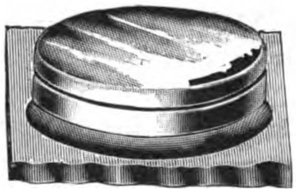


Fig. 3.—Giles' Thermostat.

TELEPHONE KERITE CABLES.

The American Telephone & Telegraph Co., better known as the "Long Distance" Telephone Co., has just given a contract to A. G. Day, of 16 and 18 Dey street, the manufacturer of "Kerite," to make and lay a cable across the Hudson river. This cable is to be of the anti-induction type and made to special specifications. It will be 5,350 feet in length, and contain 18 conductors. The cable is to be in position by June 1st, and makes another addition to the large number of Kerite cables already in operation at this point, some of which have been in uninterrupted use for nearly twenty years. The new cable will be laid under the personal supervision of Mr. Geo. B. Prescott, Jr., general agent for the concern.

STANLEY ELECTRIC CO.

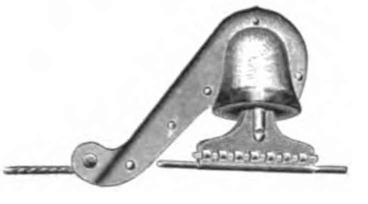
The Stanley Electric Co., of Pittsfield, Mass., has leased the second story of the Morton Building in order to have more room for its business, and the machinery is being put in position as quickly as possible.

THE PATENT CENTENNIAL CELEBRATION.

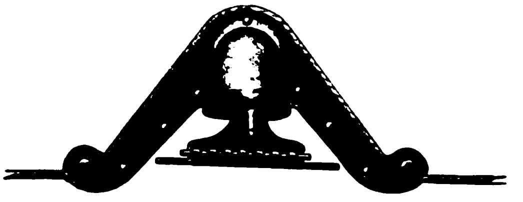
Arrangements are rapidly maturing for the patent centennial celebration at Washington, on April 8, 9 and 10. The programme has already been outlined in these pages. Among the papers of special interest to electrical engineers may be noted that of Prof. Thomas Gray, on April 9, on "The Inventors of the Telegraph and Telephone," and of Prof. C. F. Brackett, on "The Effect of Invention upon the Progress of Electrical Science." The paper of Judge Taylor, of Indiana, on "The Epoch-Making Inventions of America," on April 8, will also contain references to electrical advancement and discoveries.

ANDERSON INSULATORS.

THE "trolley wire hanger" and the "curve pull-off" described herewith, are specimens of a very strong and substantial order of overhead line devices. A composition known as the "Etna" insulating material is moulded into the bells. It is said to be practically indestructible, and to afford very high insulation. The wire-holding device is in the line of the latest development in that sphere. It it entirely simple, and would appear to be very effective. The cut shows clearly the action of the clamp when the pin is driven into place. These Anderson insulators are handled by The Electrical Supply Co., of Chicago.



THE ANDERSON CURVE PULL OFF INSULATOR.



THE ANDERSON TROLLEY WIRE HANGER.

A RUBBER INSULATED SCREWDRIVER.

THOSE who are accustomed to working around live conductors will know how easy it is to get an unpleasant shock by touching a finger to the shank of the screwdriver, and how readily the tip of the tool is burnt by shunting considerable current through the shank. All this would be avoided by having the shank insulated nearly to its tip, as is done in the case of the new screwdriver shown in our cut. The metal shank is flattened and bent into a loop at one end, and then moulded into a rubber protecting handle. Vulcanized rubber gives a high and lasting insulation and also has the toughness and durability needed in a tool-handle, hence it unsurpassed for making a reliable safeguard of this type.

A RUBBER INSULATED SCREW DRIVER.

The rubber insulated screwdriver is made in a number of sizes, suited for use in various places. George Cutter, of Chicago, has the Western agency for it, and has already sold quite a number.

"SUPERIOR MERITS," "PERFECT SATISFACTION."

The following is a recent communication received by Kidder's Electrical Depot:—

DOVER, N. H., March 17, 1891.

JEROME KIDDER MANUFACTURING Co., 820 Broadway, New York City.

Gentlemen:—

* * * I have sold several of your Faradic Batteries, which I am pleased to say are giving *perfect satisfaction*. I have a customer who wants a No. 5 Apparatus with tip battery on account of the *superior merits of the No. 5 coil* which I have explained to him.

Yours truly,

CHAS. H. DAME,
No. 11 Essex street.

Dealer in Electrical Supplies.

CINCINNATI TRADE NOTES.

THE CARD ELECTRIC MOTOR AND DYNAMO Co., of Cincinnati, are getting out a new catalogue, which is expected to compare favorably with anything of the kind ever issued. It will be tastefully arranged and profusely illustrated.

NEW YORK NOTES.

REED & MCKIBBIN, the consulting electrical engineers and contractors, of 32 Liberty street, will remove on May 1 to 2 Wall street. They succeed to the business of Thompson, Reed & Co.

WESTERN TRADE NOTES.

THE ELECTRICAL SUPPLY CO., of Chicago, is pointing with considerable pride to a large order for Shield Brand wire just taken in a Western city. This pleasant state of mind is due, not so much to the size of the order, though it was a handsome one, as to the fact that it was taken in the face of unusually urgent competition. The E. S. Co. attribute this success to the well-known merit of the wire, and not to exceptional selling abilities. "It is the moisture-proof quality that counts."

THE GLOBE CARBON CO., of Cleveland, O., are going to build new works, right away, of treble their present capacity. Their business is increasing so rapidly that in their present quarters they find it difficult to keep pace with their orders. Their new factory will be pushed right through and they will then be in a position to meet the largest demands in the most prompt manner.

THE BALL ENGINE CO., manufacturers of high speed automatic cut-off engines, Erie, Pa., are very busy filling orders for their well-known engines. They are largely extending their capacity. Such a general favorite for electrical and other power purposes has this engine become that this step has been found an imperative necessity. Their new building is now well under way, and when completed will make the factory one of the most extensive and best equipped of its kind. They are just shipping a 250 h. p. cross compound condensing for the Buffalo electric street railway plant, and a 300 h. p. triple expansion engine to Rochester for street railway work.

NEW ENGLAND TRADE NOTES.

THE PETTINGELL, ANDREWS COMPANY report business as beginning to be brisk for the spring, after some weeks of unusual slackness. They have recently received some large orders for supplies, and are paying special attention to electric railway specialties. Among their most recent contracts is one for the complete equipment of feeder wire for the Springfield Electric Railway Company, Springfield, Mass., which calls for several miles of heavy insulated wire. They have also the order for line wire equipment of the Holyoke Street Railway Company, and they have just received a very comprehensive order for feeder wires, and all electric fittings and supplies, for the Newburyport and Amesbury Street Railway Company, of Newburyport, Mass. The Newton and Watertown Gas Light Company, of Newton, have also sent them some large orders for wire recently, and altogether the prospect for a good business is extremely bright.

THE EVANS FRICTION CONE COMPANY, of Boston, report the sale of their frictional system of driving to the following plants: Wm. Ruehl Brewing Company, 200-light dynamo; Edison Electric Illuminating Company, New York, friction for motors for ventilating machinery; Westinghouse Electric Manufacturing Company, Pittsburgh, for an electric plant on a government steamer, the engine and dynamo being on the same bed-plate; Derby Gas Company, Birmingham, Conn., for 50 arc light dynamo; Hughes & Gawthrop Company, Pittsburgh, for 50 arc light dynamo; Thomson Electric Welding Company, Lynn, Mass., for 100-light dynamo; Bridgeport Electric Light Company, Bridgeport, Conn., for four 50 arc light dynamos; Brooks Bank Note and Lithograph Company, Boston, for 100-light dynamo; Ames Building, Boston, for two 275-light dynamos.

MR. W. H. ELKINS has just perfected an arc light dynamo with an absolute system of regulation. All arc light dynamos in the market to-day require a regulator to protect the dynamo, when lamps are suddenly cut out of circuit. Mr. Elkins has been at work on the subject of regulation for years, and has already patented several regulators, but has now discovered a method of winding a dynamo by which he gets a perfect regulation. He can cut out any number of lamps at once without interfering with the running of the machine, or heating the armature or fields, and can short circuit the machine 60 times a minute (for the purpose of testing it) without any injurious effect. It looks as if Mr. Elkins had a valuable patent.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

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EXPERIMENTS ON THE TRANSMISSION OF POWER AT VERY HIGH POTENTIALS.

PROBABLY the most notable feature of the Electrical Exhibition at Munich in 1882, was the demonstration by Deprez, of the practicability of transmitting power electrically over long distances. For this purpose, it will be remembered, Marcel Deprez employed two machines, one acting as a generator at Miesbach, and a second as a motor in the exhibition building at Munich, 37 miles distant, the current being sent over an iron telegraph wire 4½ mm. in diameter. The difference of potential at the generator was 1,343 volts and that at the motor 850 volts, while the actual work at the motor measured only ¼ h. p.

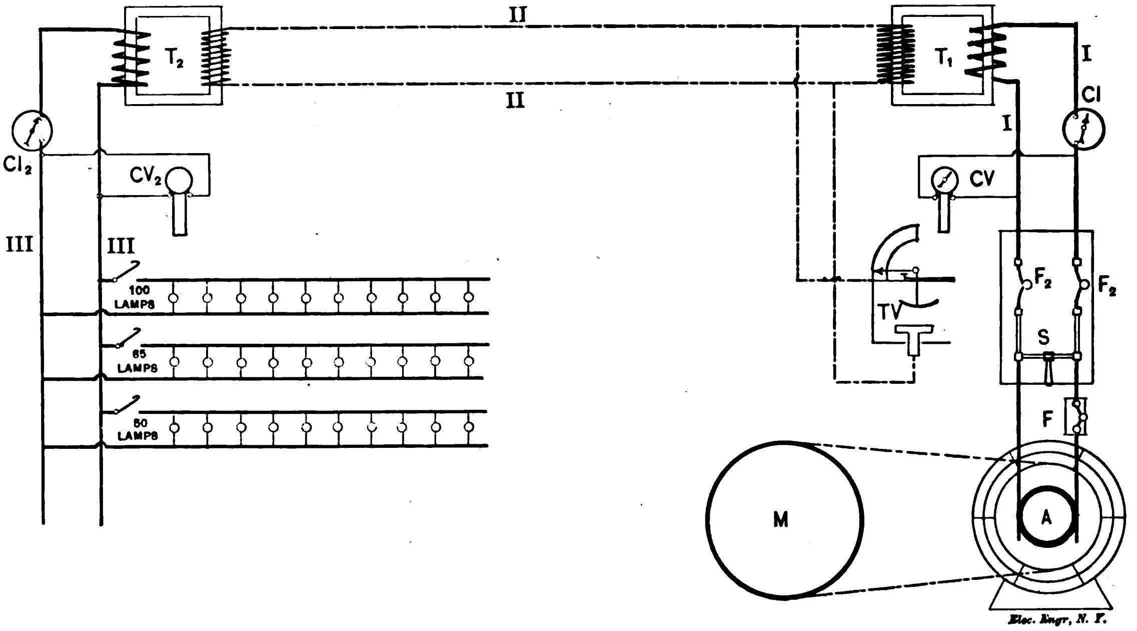


Fig. 1.—Electric Power Transmission at 30,000 Volts Potential.

As a demonstration of the improvements introduced since that time no better example could be afforded than the high tension transmission which it is proposed to show in connection with the Frankfort, Germany, electrical exhibition to be held during the present year.

The plan contemplates the transmission of 300 h. p. of the water power of the River Neckar, at Lauffen, to Frankfort, a distance of nearly 115 miles, by means of a copper wire 4 mm. in diameter. To accomplish this without very heavy loss in the conductors will evidently necessitate the employment of very high potentials, and in order to obtain data for the proposed work, a test installation was recently made at the works of the Oerlikon Company, near Zurich, who, in connection with the Allgemeine Elektricitätsgesellschaft, of Berlin, will undertake the transmission referred to.

Unlike the Deprez experiments, the present will be carried out by the aid of the alternate current transformer. The arrangement of the apparatus in the preliminary test is shown in the accompanying diagram, Fig. 1, in which I represents the generating station, II the line, and III the receiving station. As will be seen, an alternator A was directly driven from the motor by belting, and by changing the speed, the potential could be varied from 40 up to 100 volts. The alternator generated a heavy current at a low voltage. For the proposed installation at Lauffen, the voltage will be 50 volts and the current 4,000 amperes. In this respect the system differs materially from the ordinary alternating current transformer systems. According to the opinion of the Oerlikon firm, the employment of wires of large size, with consequent decrease in the number of coils, will allow of a cheap construction of the dynamo, and afford much greater safety of operation. Quite apart from other advantages, the low voltage of the alternator removes the factor of danger for the attendants during the operation. From the alternator, the low potential current is carried to the transformer T_1. On the way it passes through a single pole fuse F, through a double-pole single-throw switch S, and double-pole fuse F_2. In case of a fault in the insulation arising from too heavy load, or of a short circuit, the current would increase so much that the fuse, of the Cockburn type, will be blown; the weight of the leaden ball, suspended from the leaden fuse wire, tears apart both ends of the same, so that the circuit cannot be closed again by the two ends of the fuse melting together. The current is measured in the primary circuit by the current indicator C I, and its potential by the Cardew voltmeter C V.

The transformer T_1, designed by Mr. C. E. L. Brown, of the Oerlikon Works, is shown in two views in Figs. 2 and 3. It consists of a rectangular laminated iron core, on which both the primary and the secondary windings are placed, insulated from each other. The magnetic circuit is closed by two U-shaped iron pieces.

Experiments have proven that for such high potentials, hard rubber a few milimetres thick is only a safe insulator as long as it is absolutely homogeneous ; as soon, however, as it gets a crack, the air which enters allows discharges of electricity to take place. Some kinds of oil have proven to be as good insulators as hard rubber. In order to prevent a discharge in the transformer, the latter is placed in a vessel filled with oil, the latter thus filling out all interstices and expelling the air which endangers the insulation. According to Mr. Brown's information, these transformers have proved to be quite safe, even at a potential of 50,000 volts. The transformer has a ratio of one to three hundred. The primary potential of the alternator of 40, 50, 65, 100 and 110 volts used for the experiments, thus produced a potential of 10,000, 15,000, 20,000, 30,000, 33,000 volts, respectively, in the secondary circuits. In the experiments, the line consisted of 7 kilometres of bare copper wire, 4 mm. in diameter, mounted in four parallel rows on the same supports by means of Johnson & Phillips oil insulators. The type of insulator proposed for the actual line from Lauffen to Frankfort is shown in Fig. 4.

The insulation of the line was tested by means of artificial rain, produced by the spraying of water from a hose. A Cardew voltmeter connected with the high potential secondary conductor indicating up to 100 volts, was connected to earth, and did not show any deviation. During a snow storm which took place, the same line did not show any leakage. The number of insulators used for this test amounted to 120. The Oerlikon works made use of spans of 80 to 100 metres, with copper wire of 4 mm. diameter. The oil insulators employed thus represented the insulating resistance of a line 10 to 12 kilometres long.

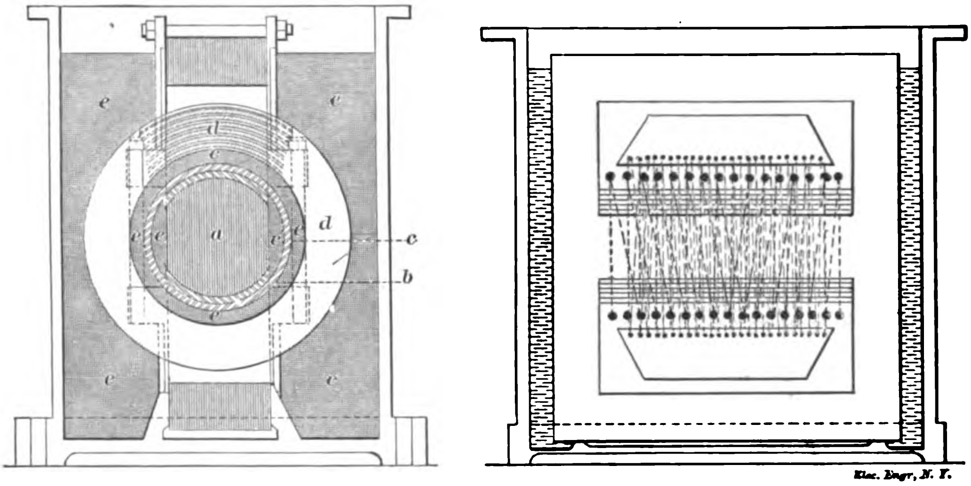
In the secondary circuit. the potential was measured by means of a Sir William Thomson voltmeter TV, which can be used for measuring potentials as high as 50,000 volts. A comparison made between the indications of this instrument and those of the Cardew voltmeters CV gave very satisfactory results. The secondary circuit is connected with a transformer T_2. Its ratio of conversion is also from 1 to 300, so that it reduces the voltage on that of the primary conductors equal to that of the alternator. This transformer is also placed in a vessel filled with oil. The tertiary circuit at the receiving station had connected with it the current indicator CI, a Cardew voltmeter CV, and three series of 10 incandescent lamps run in multiple for 50, 65 and 100 volts, which could be switched on or off by the switches SS.

Special interest was excited by the experiments in the working of the fuses, and the induction in a telephone wire running parallel close to the power transmission line. The fuses were tested by making a direct short circuit, as well as by making use of the discharge current. They were inserted in the primary circuit because the small current used in the secondary circuit would necessitate the use of too fine wire. As soon as the secondary circuit was short circuited by means of a copper wire, the fuse was instantly blown. The short circuit was made by dropping a bare copper wire on the two secondary conductors. As is known, the blowing out of the fuses is accompanied by a small explosion ; it was impossible to notice the smallest difference of time between the noise of the short circuit in the secondary wire and the explosion of the fuse. The extraordinary quick working of the fuse was proved by the fact that neither the secondary wires nor the copper wire used to produce a short circuit showed any traces of burning, notwithstanding the fact that the numerous short circuits which were made caused the copper wire and the conductors always to touch each other at the same place.

In order to produce a discharge, two pieces of wire were connected with the secondary conductors, placed 22 millmetres apart. As soon as the secondary potential attained about 18,000 volts, the first discharges, accompanied by a dim light took place. At a higher voltage an arc was produced, causing at the same time interruption of the current by the blowing of the fuse.

In order to investigate the effect of the secondary current on telephone circuits, a telephone loop was run on the same poles carrying the secondary wires. It must be remarked that the secondary wires were arranged in four parallel rows, in order to enable the large amount of wire to be stretched within the limited space available for it. The speaking through the telephone did not meet with any difficulties, although their was a small noise caused by induction.

The experiments, which have been of a qualitative character, proved that the transmission of power installation between Lauffen and Frankfort will not only be possible, but also absolutely safe. The working of the fuses evidently proved that short circuits which might happen by the falling or bending over of poles, will cause an instantaneous interruption of the whole plant. In the some way the installation, tested under very unfavorable circumstances, proved to be highly satisfactory.



FIGS. 2 AND 3.—TRANSFORMER FOR 30,000 VOLTS POTENTIAL.

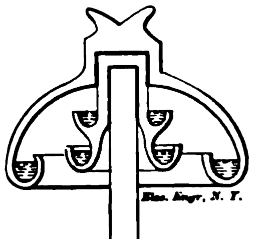


FIG. 4.—OIL INSULATOR.

LIVINGSTON, MONT.—The Livingston Electric Light Company have executed a mortgage to the Minneapolis Trust Company for $30,000 upon their plant. This money is secured to take up floating indebtedness and for the purpose of increasing the plant and extending the service.

THE STANLEY TRANSFORMER.

Mr. Wm. Stanley, Jr., whose brilliant successes in the alternating current field are well known, has recently organized the Stanley Electric Manufacturing Co., of Pittsfield, Mass., where work is now actively going on in the development and manufacture of a series of electric lighting specialties.

Among the first fruits of Mr. Stanley's labors is an improved transformer, in which he has embodied methods of construction which have increased not only the electrical, but also the mechanical efficiency of this important piece of apparatus.

Considering first, the electrical efficiency of the new Stanley transformer, which is shown in the accompanying engravings, the 20-light converter at full load has been found to have an efficiency of 94.3 per cent., and its peculiar design makes it possible to obtain a very high efficiency even on so small transformers as five-lighters. The percentage of variation of E. M. F. in the secondary, between full and light load, is only 1.3 per cent.

Other things being equal, one of the best tests of the commercial value of any apparatus is the amount of useful work done per unit of weight, and in this respect the Stanley transformer shows up very favorably, the 20-light transformer, for instance, giving 12 watts of useful energy per pound of weight.

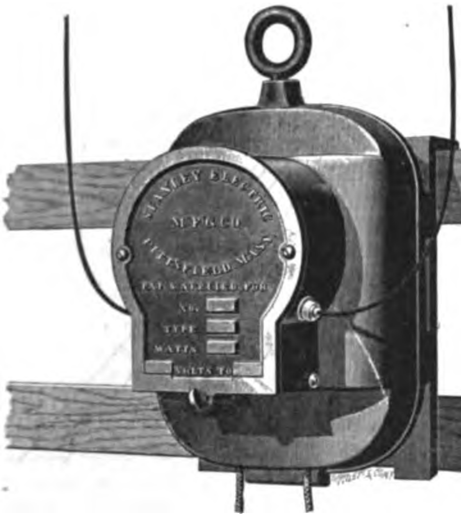


Fig. 1.—The Stanley Transformer.

The arrangement of the fuses so as to allow of easy and safe handling of the transformers has been very neatly worked out by Mr. Stanley, and is clearly shown in the engraving Fig. 2. As will be noted, the secondary fuse is done away with entirely, as every secondary is fused where it enters a building. The primary fuse wire or link is carried on a porcelain block or plug, and can be secured in place while the block is held in the hand. The station may have a number of extra plugs, and, to replace a fuse which burns out, it is only necessary to open the door by turning a thumb-screw, remove the plug, insert another and shut the door; or a new fuse may be attached and the same plug replaced. The same size of plug fits all different sizes of transformers up to 100 lights.

The fuse box is entirely of porcelain, every part being thus perfectly insulated and fire-proof. The two fuses are entirely separated by the porcelain partition in the fuse-box, thus preventing any chance of short circuit from one to the other, and the unusual length of the fuse itself, insures a complete rupture of the circuit and prevents any possibility of arcing.

The insulation of this transformer possesses a very great resisting power to high potential discharges, and the method of winding the coils renders the chance of a cross extremely remote.

The new Stanley transformers are made in sizes of 5, 10, 20, 30, 40 and 100 lamps capacity, and are wound for both 1,000 and 2,000 volts primary, with either 100 or 50 volts secondary. The company is also prepared to build special transformers for any desired purpose.

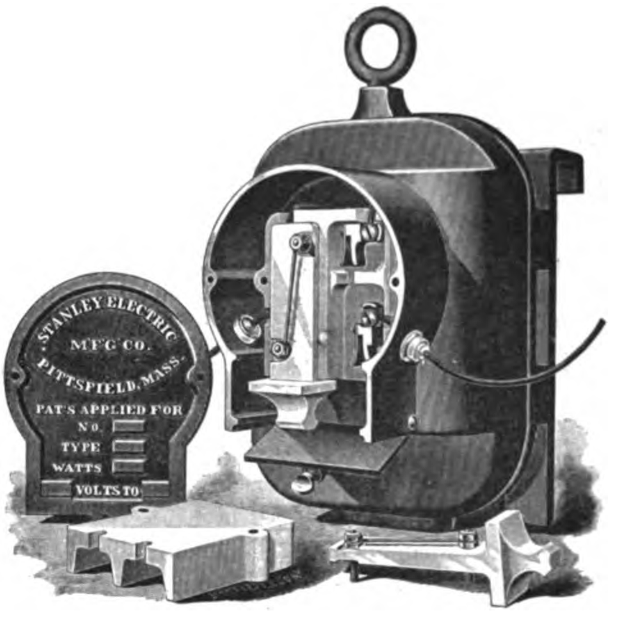
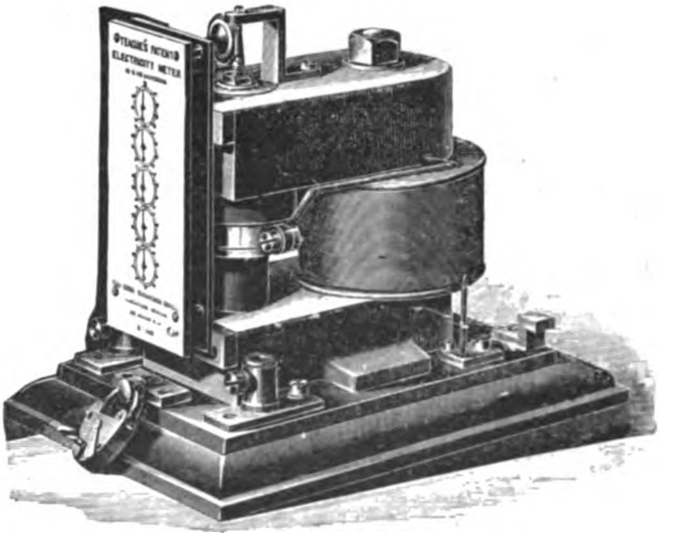


Fig. 2.—The Stanley Transformer.

THE TEAGUE METER.

At the Electrical Exhibition now being held at the St. Pancras Vestry Hall, London, is shown the Teague watt-meter, manufactured by the Acme Electric Works, and represented in the accompanying illustration.



The Teague Meter.

This meter consists of a horse-shoe electro-magnet with a hollow revolving cylinder or drum inserted in an annular space bored near the pole. The series current enters at the bottom by the axis of the cylinder, which projects into a mercury trough, passes thence to the top, radiates by the cap of the cylinder to the exterior, and passes down to another mercury trough. In its arrangement the meter resembles that designed by Mr. Weston some years ago.

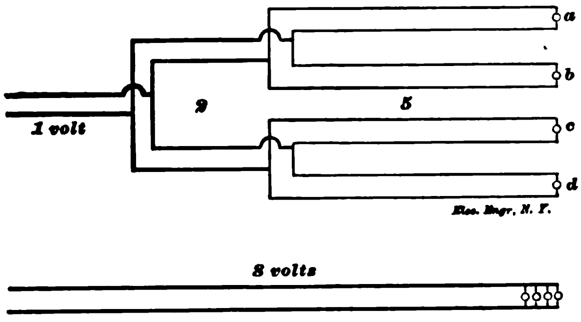
RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.—II.

BY

Carl Hering

To calculate the wires for a building with independent lamps, lay them out so as to approach as nearly as practicable the best distribution as described above, making common mains as short as possible, and individual branch wires as great a proportion of the whole as possible; then determine on the total loss, for instance, four volts, and divide it amongst the leads so as to have as small a part as practicable (say, one volt) on the common main, and the other part (three volts) again divided, if necessary, on the distributing branch wires. Calculate the size of each wire from the number of lamps supplied by it, and from this portion of the total loss allowed for that part of the whole lead. The lamps will then be dependent on each other only in so far as they are on common wires, and to an amount that other lamps effect the loss only on this common wire.

To illustrate some of the points mentioned above by an actual (exaggerated) case, suppose the leads for four lamps, *a*, *b*, *c*, *d*, Fig. 4, be subdivided as shown, and suppose the total loss of 8 volts be divided into 5, 2 and 1, as indicated, on the separate mains and branches; the relative distances being in the proportions of the diagram. The loss is proportionately small on the common mains and large on the individual branches. Now, taking any one lamp, as *a*, its voltage will be increased as follows: With *b* turned off, 1¼ volt; with *c* or *d* turned off, ¼ volt; with *c* and *d* both turned off, ½ volt; with *b*, *c* and *d* turned off, 1¾ volt. This shows that lamp *a* is dependent on the others in proportion as it is on common mains with them, and on the loss of volts on the common mains, which is small in this case.



FIGS. 4 AND 5.

Now, for the sake of comparison, let the four lamps be supplied by a single pair of mains, as in Fig. 5, with the same loss of 8 volts. Turning off one lamp increases the voltage of the others, 2 volts; with two lamps turned off, 4 volts; and with three lamps off, 6 volts. This shows how very great the difference is, namely, a maximum of 6 volts in Fig 5, as compared to 1¾ volts in Fig. 4. The weight of wire in Fig. 4 is only slightly higher, namely, as 23 to 20. If now, the wire in Fig. 5 be made larger, so as to have the same maximum *variation* in volts as in Fig. 4, namely, 1¾ volt, the total loss would have to be 2 volts, and this would increase the weight of wire to about three times that in Fig. 4, showing the advantage in subdividing the leads, aside from the fact that Fig. 4 is a distribution, (as the lamps might just as well be at the same distance in different directions) while that in Fig. 5 is not. The actual figures will, of course, vary greatly under different circumstances, and no general statement can be made regarding the amount of gain.

In referring to the dynamo, in the above deductions, it was understood to mean the place from which distribution begins, that is, the centre of distribution, or the common point at which the potential is kept constant. In wiring large buildings or spaces, it is usual to run a pair of large mains to a central point from which distribution begins; this pair of mains, provided it is the only one from the dynamo, is not included in the above discussion, as it is supposed that the dynamo is so regulated as to keep a constant potential at the far ends of this pair of mains, that is, at the centre of distribution; if the dynamo does not do this, or if there is more than one pair of such mains, then it brings the centre of distribution back to the dynamo, thus making these mains part of the distribution.

A great mistake is often made in supposing that a dynamo can keep the potential constant at more than one distant centre of distribution, without special apparatus at the dynamo. This refers, of course, to a system of independent lamps. Suppose all lamps are turned on at one centre, and only one lamp is on at the other, this lamp will be run too high, as the dynamo must be kept at the same high potential on account of the lamps on the other centre. It can be accomplished only in one of two ways, first, approximately, by making the loss on the mains very small; secondly, by regulators in each of the original branches from the dynamo.

It has been suggested to put lower voltage lamps at the most distant centres, and higher voltage lamps at the nearer ones, on account of the greater loss in the longer mains. It is a question whether this is practicable, for a number of reasons. A lower volt lamp requires a greater current and for this reason alone, a larger wire. It is not a good practice to have lamps of differing voltages in stock for one and the same building or installation, unless there is a reliable person to take charge of their proper placing.

In the three-wire system there are practically two lamps in series, and, therefore, the current need be sent out and back only once for every two lamps; this requires but half the wire (in cross section) otherwise necessary for the same number of lamps. Furthermore, the loss of volts is divided between two lamps, and it can therefore be made twice as great as in the simple system; this halves the quantity of wire again, making the total one-quarter as great as for the two-wire system. To carry the current for any lamp which may not at the time have another in series with it, a third or neutral wire is laid, which, in wiring buildings, is usually made the same size as the other two; this increases the wire by a half, making the total three-eighths of that required for the simple system. To calculate the leads for the three-wire system, proceed as in the simple system, and divide the cross section obtained by four, using three wires of this cross section. The same result would, of course, be obtained by using one-quarter the number of lamps, or one-quarter the distance, or four times the loss.

Fusible cut-outs.—The general principle of safety or fusible cut-outs is that they protect from a dangerous excess of current those wires which are *beyond* them, as distinguished from the wires between them and the dynamo, which are not protected by the fuses. They should therefore always be placed at the *beginning* of a wire (that is, at the end toward the dynamo) and not at the lamp end. Furthermore, they should be made so small that they protect the *smallest* wire lying beyond them, up to the next fuse; this is not infrequently overlooked, and may be a source of great danger. A thick wire is sometimes protected by a large fuse, because it is a thick wire, nothwithstanding that a small wire is attached to it, unfused; there is always great damage in such cases. It follows, therefore, that whenever the wire changes its size, a fuse should be placed, unless the fuse preceding it is small enough for the smallest wire beyond it. In general, therefore, a fuse should be placed at the beginning of every branch circuit, except as explained.

If only one side of a circuit is protected by fuses, the building is not completely protected, as there are possible cases in which a wire might become overheated, as, for instance, when a heavily fused wire and a light unfused wire are both grounded or in contact. Fuses should therefore always be "double-pole."

It has been suggested to make the fuses of copper wire of a certain number of sizes smaller than the size of the wire to be protected by it. This would be a very good general rule and guide, but the temperature of the fused copper is so very much higher than that of lead alloys, that there would be danger of fire caused by scattering of this melted copper.

Fuses should be marked with the current at which they will fuse, but as such marks are sometimes very unreliable, even with fuses sold by otherwise reliable companies, a careful engineer will always test a sample fuse before using them. Some fuses are marked with the number of lamps normally supplied by them, others with amperes, others with the fusing current, etc.; unless it is known what such marks mean, it is not safe to trust them.

THE VERSTRAETE CONDUIT AND TROLLEY FOR ELECTRIC RAILWAYS.

The accompanying illustrations show a conduit and trolley system for electric railways invented by Mr. Edmond Verstraete, an electrician of the railway department of the Thomson-Houston Electric Co., and now in charge of the electrical installation of the Union Depot R. R. in St. Louis. The system is applicable to the ordinary cable conduit although a specially constructed conduit is more suitable for rapid construction. Fig. 1 is a transverse section and Fig. 2 a side elevation of the conduit and trolley, from which it will be seen that at the bottom of the conduit is placed a light T rail, on which travels the trolley truck. The trolley is supported on two double flanged wheels arranged tandem between the two main plates or frame pieces.

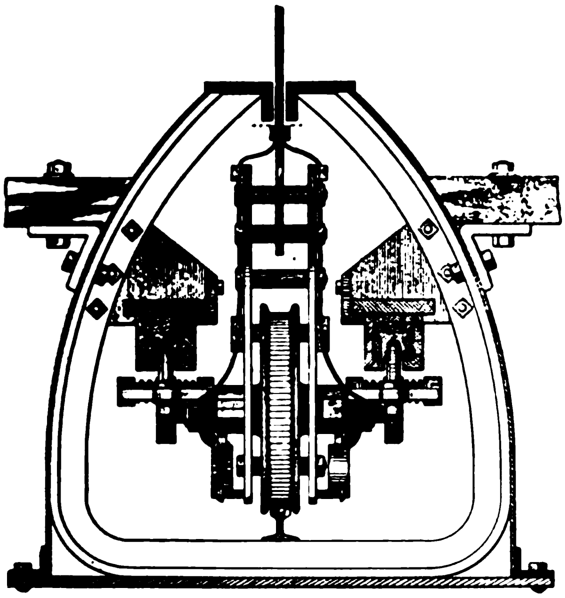


Fig 1.—The Verstraete Railway Conduit.

Four contact wheels, two on each side of the frame, make connection with the positive and negative mains. The contact wheels are carried on the ends of four levers which are pivoted on a centre common to all, and are pressed upward by means of counterweights or springs which cause the wheels to be kept in constant contact with the supply mains.

The axles of the contact wheels have a limited lateral motion in their bearings, and coiled springs are placed on the axles on each side of the wheels to give them an elastic motion laterally. The contact wheels are insulated from the hubs by means of a web of insulating material, and the rims of the wheels make contact with four spring shoes which are also insulated from the frame piece by means of insulated binding posts. Two binding posts on one side are connected together forming, say, a positive lead, while the two binding posts on the other side are also connected together, forming the negative lead, both of which are carried upward through two separate spaces or channels in the main column to the motors and controling devices on the car.

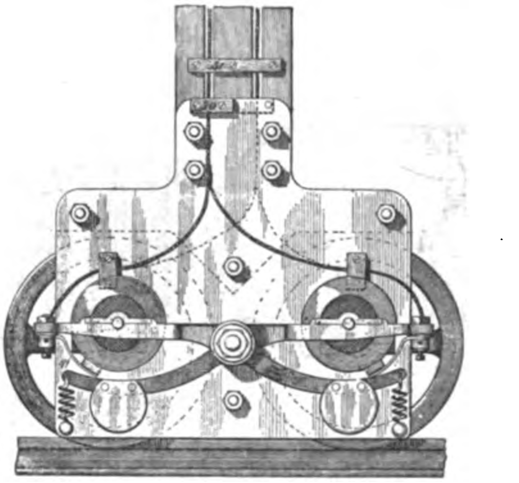


Fig. 2.—The Verstraete Railway Conduit.

The mains are formed of bars of channel iron, as shown in Fig. 1. The bars can be made of any length and are joined together by expansion joints to provide for expansion and contraction. The bars being of considerable sectional area, can, when properly bonded, be made to carry the entire current without feeders.

In construction, the mains are first laid in the wooden boxing, which has a longitudinal opening in its bottom conforming to the channel in the bar. The boxing is well clamped into position and then filled with an insulating compound, which is run in while hot, and when well set the cover is fastened on. The entire main, except its under or channelled part, is therefore entirely covered with insulating material. The boxing is supported by cast iron brackets attached to the yoke pieces at regular intervals.

THE HUNTER AUTOMATIC SHUNT.

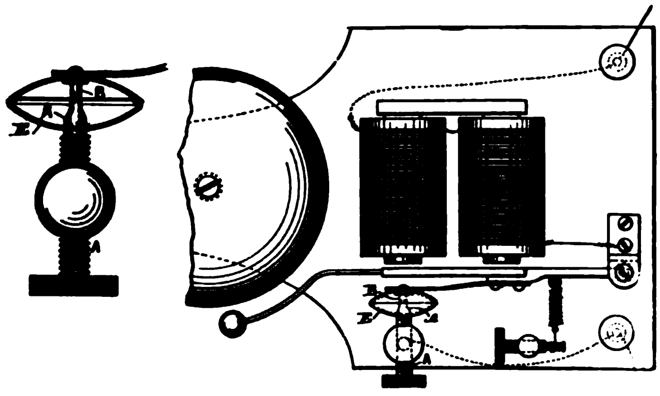
In the employment of incandescent lamps in series lighting, it is necessary to maintain constant current on the line, even though one or more lamps give out. To effect this, Mr. Rudolph M. Hunter, of Philadelphia, has invented an arrangement in which the current in the line is greater than that required in any one lamp in the series; part of this current is shunted about each lamp, the resistance of the shunt being so proportioned that all of the current necessary for the lamp will pass through it. In addition to this resistance, an auxiliary resistance-reducer is provided which still further reduces the resistance to the line-current upon the rupture of the lamp-filament, or the cutting of the lamp out of circuit. This auxiliary resistance is cut out or reduced by the action of the heat produced by the heavy duty upon the shunt when the lamp is cut out.

When the shunt is unduly heated by too great a flow of current, a column of mercury in a tube about which the shunt is wound, is made to expand by the heat of the overloaded wire, and completes an auxiliary circuit, thus lowering the resistance of the shunt as a whole, and completely shunting the lamp.

VARLEY'S ELECTRIC CONTACT PROTECTOR.

Great difficulty is frequently experienced in the electrical operation of call bells, in consequence of particles of dust or other foreign substances getting in between the contact points, and the risk of the alarm becoming inoperative is augmented by the fact that considerable periods of time often elapse during which the call is not in use.

In order to obviate this, Mr. Richard Varley, Jr., of Englewood, N. J., electrician at the works of the Okonite Co., has invented the device shown in the accompanying illustrations. As will be seen, the contact A is in the form of a screw with a platinum plug, and the other contact B, is held by the spring attached to the armature.



Varley's Electric Contact Protector.

The protector E is made of thin sheet rubber that extends from one contact to the other, forming a dust-proof inclosure. This protector is made of two discs with a central opening in each, one fitting around the button head of the contact B, and the other around the end of the screw A. The discs are united at their edges and vulcanized, thus excluding all dust. Hence it is not necessary to enclose the bell or magnet in a case, as is sometimes done, to aid in keeping the bell in working order.

The protector can be similarly made for the contacts of a telegraph key, the contact studs having heads with annular channels or necks for the edges of the elastic discs.

THE COATING OF INCANDESCENT LAMP FILAMENTS.

The ordinary custom of coating the filaments of incandescent lamps with deposited carbon is open to some objections, from the fact that, carbon being a fairly good conductor, it is necessary either to make the filament exceedingly fine, with a sufficient protection of deposited carbon, or larger with an insufficient protection.

To overcome this difficulty, Messrs. Georg Erlwein and F. G. A. Heller, of Berlin, have invented a method of depositing a solid coating of incandescing material, consisting of the metallic carbides of various difficultly fusible metals. Owing to the smaller conductivity of these compounds, as compared with carbon, the coating may be made much thicker than that now in general use, admitting, therefore, of the use of thicker cores, and increasing the life of the lamp.

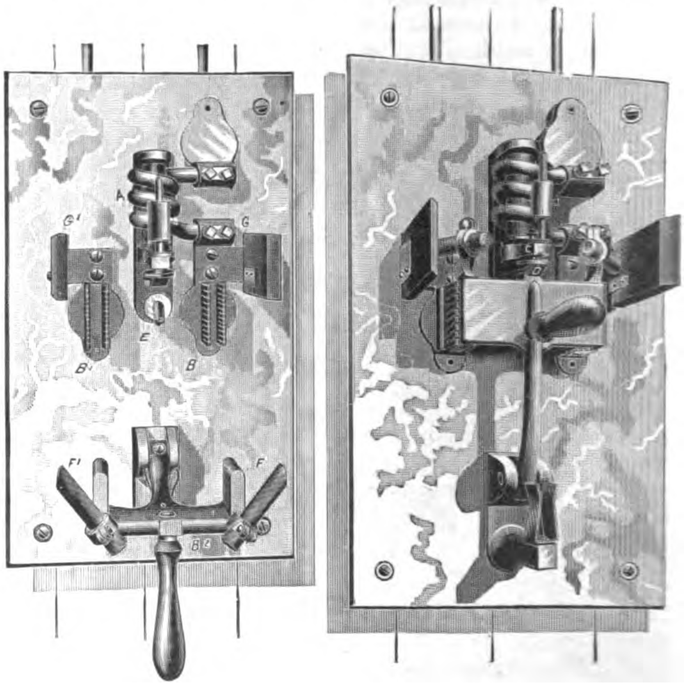
The method of deposition is as follows :

The metal or base of the carbide is deposited upon the carbon filament simultaneously with carbon from volatile metallic compounds in the presence of a hydro-carbon and hydrogen, or the carbon filaments, saturated with the easily-reducible compounds poor in oxygen, are heated to incandescence in an atmosphere of some hydro-carbon. The metals are reduced by the heat, and at the same time a deposit of carbon is made upon and among the particles of metal, or the metal may be reduced and the carbon deposited in any other way, and thus the reduced metals enriched with carbon. Among the metals suitable for this purpose are mentioned iron, chromium, and manganese.

THE WESTINGHOUSE AUTOMATIC CIRCUIT BREAKER.

Street railway men who have operated street cars and have used in their station the ordinary fusible block, and the make-and-break switch, know how difficult it is to keep their switch-board looking well, especially when they have had a number of short circuits on the line. Not only are the safety-fuse blocks burned and discolored, but the portion of the switch-board near the safety-fuse is also injured, and in addition to the above, the jaws of the switch are partly melted or fused, and the whole presents anything but a neat appearance. In order to avoid this, the Westinghouse Electric and Manufacturing Co. have devised an automatic circuit breaker, which breaks the current automatically whenever there is a short circuit on the line, without burning or in any way disfiguring the breaker itself. It has been tested on as high a current as 900 amperes and 500 volts, or a total of 450,000 watts, without in any way affecting or burning the breaker.

The accompanying engraving, Fig. 1, is a view of the breaker when open, and Fig. 2 represents it closed. The circuit breaker consists of an electro-magnet, A, in series with a double break switch—B, B^1 and B^2. If a short circuit occurs on the line, the electro-magnet will attract its armature, C, and with it the trigger, D, which holds the switch closed, and thereby allows the spring, E, to throw the lever arm out of the contacts. This, however, does not yet open the circuit, as the carbon contacts, F and F^1, carried by the lever arm still touch the carbon plates, G and G^1, at the sides of the switch and at those carbon points the circuit is finally broken without injuring in the least the metal parts of the switch. The feeder switch should always be opened before the circuit breaker is closed again.



Figs. 1 and 2.—Westinghouse Automatic Circuit Breaker.

The point at which these circuit breakers will cut out, can be regulated by changing the weight, H, attached to armature. The Westinghouse Co. make two styles of circuit breakers, viz., one to work on feeders up to 400 amperes capacity, and one to work on feeders from 400 amperes to 800 amperes capacity.

AN INCANDESCENT LAMP FACTORY IN THE NORTHWEST.

BY

H. Norman Collins.

Among the new and important industries of the Northwest, a section of the country that has had an unprecedented and remarkably rapid growth during the past few years, is the incandescent lamp factory recently started by the Standard Lamp Company, of Appleton, Wisconsin. The new company is strongly backed financially and the field for its operations is very extensive, as evinced by the large volume of business already being done by the new concern, although of comparatively recent organization.

The writer having been cordially invited to inspect the new lamp industry has embodied his observations during a pleasant visit there in the following, which, it is hoped, will prove of interest and possibly instructive to those not versed in the process of incandescent lamp manufacture.

The factory of the company is located on the Fox river, on the lower dam, and comprises three buildings, the largest of which is 150 x 60 and three stories high, the others being somewhat smaller and only two stories in height. In the main building is located the dynamo room, and it is worthy of notice here that this factory is entirely operated by water power, being, probably, the only lamp factory so operated in the country. Five dynamos are employed, two each of 150 volts and 250 lights capacity, of the Mayo pattern, direct current; two of 500 volts and 50 amperes, used for treating purposes; and an alternating current machine of 500 volts and 50 amperes capacity, which is of special design and has been imported from Paris, and used for a special and improved method of treating the 50 volt lamps.

The water at present utilized is 225 h. p., obtained from three Leffel water wheels, which are controlled by a new electrical regulating device, designed by Messrs. A. F. & E. L. Oppermann, the electricians of the company. This apparatus maintains the power constant within a variation of one per cent. under all changes in load and enables the greatest uniformity to be obtained in the product. Another noticeable feature is an Archimedean screw for forcing the mercury into the pumps, dispensing altogether with the vacuum power pump.

The carbonizing room occupies all the remaining portion of the lower floor and is fitted up with specially designed furnaces for the carbonizing of the filaments.

On the next floor is the glass room, shown in the accompaning engraving, Fig. 1, in which the glass blowers are at work sealing in lamps and making pumps, etc. The pump room, Fig. 2, is also on this floor, and at present there are 120 pumps in operation. These are of a specially modified Sprengel type, adapted for obtaining the highest possible vacuum, and have several improvements over the ordinary Sprengel, being designed by Mr. W. H. Sauer, superintendent of the glass department, and whose efforts in this line are well known. The socketing and lamp base department is also on this floor.

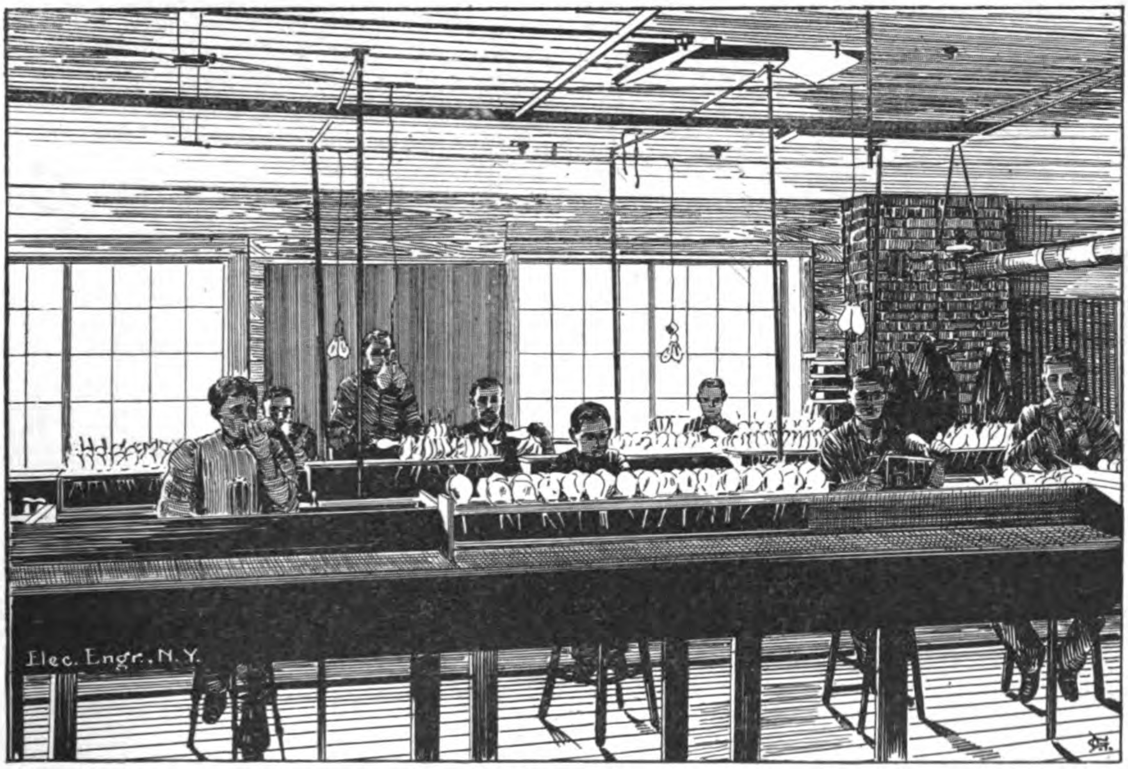

Elec. Engr. N.Y.

Fig. 1.—Glass Blowing Department, Standard Lamp Factory.

The third floor is entirely devoted to the testing room, which is fitted up throughout with the necessary testing apparatus. For this department, Messrs. Queen & Co., of Philadelphia, are now engaged in manufacturing a new pattern photometer of the most delicate sensibility to meet the requirements of the constantly increasing business.

The treating department is provided for in the larger of the two other buildings and occupies both floors. This process is of a secret nature, but as the writer was courteously permitted to inspect this work, he had an opportunity to notice the extreme care and precision with which every portion of the work, down to the most minute details, is carried out, and he can say from practical demonstration that the toughness and homogeneity obtained by this process must necessarily be conducive to long life and high efficiency. Ten sets of treating apparatus are employed in this department and it is remarkable with what dispatch and facility the work is accomplished under this system. The greatest care has been taken to prevent danger from fire, and should one break out it will be met with an efficient system of grenades and portable fire engines.

The other two-story building, referred to above, is utilized as a warehouse and in it are stored a large stock of globes and raw material employed in an extensive manufacture of incandescent lamps.

It will no doubt be of considerable interest to give some details regarding the manufacture of these lamps, which the writer has had the privilege of carefully inspecting, from the raw material to the finished lamp. Commencing with the filament, which is made from a peculiar kind of silk thread expressly manufactured for this purpose, of an exceedingly close texture and of remarkable strength in proportion to its cross-section, the process of making a complete lamp is as follows : The silk thread is first subjected to a chemical treatment which destroys entirely the animal matter, leaving a structure of great density and strength, and possessing new properties, not heretofore inherent in the silk, which have the very desirable result of lengthening considerably the life of the filament and expunging those elements which usually cause blackening or discoloration after comparatively short use. This process, as far as the writer knows, is peculiar in its entirety to the Standard lamp.

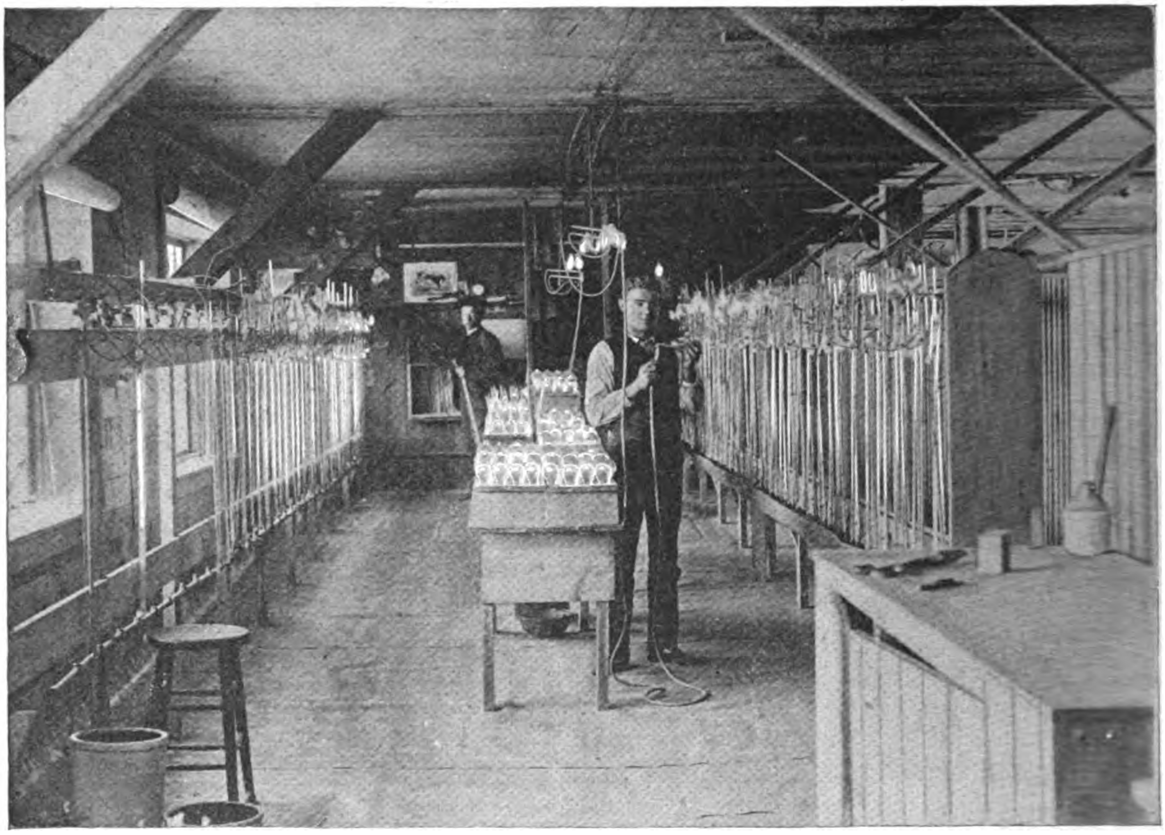


FIG. 2.—PUMP ROOM ; STANDARD LAMP FACTORY.

The next operation is to wind the chemically prepared fibres on to blocks of hard gas retort carbon of the shape and form of the intended filaments. This is effected by means of a winding machine which insures an even and equal tension and maintains the fibres evenly distributed upon the carbon-block forms. A binding thread is then wound around the blocks and fibres at right angles, thus holding them firmly in place upon the block, after which the bottom ends of the fibres are severed. The whole arrangement is then placed in the carbonizing retort among a number of others of similar character, all being embedded in a carbonaceous compound, and the retort is then placed in a special furnace and maintained at an even white heat which is carefully regulated and maintained for a number of hours.

After this baking process the fibrous filaments are taken from the crucible and removed from the carbon blocks and cut to the requisite length to give the desired resistance for the voltage required. They are now found to possess a very different appearance, having become transformed to a carbonized fibre of a highly homogeneous structure, possessing great hardness and resilience.

At this point it is necessary to digress somewhat and explain the *modus operandi* of preparing the stems in which the filaments are mounted. In the first place, the platinum wires for making connection between the filament inside the globe and the cap or lamp-base, are cut to the necessary length and their ends are then separately flattened out by means of a press and formed into minute tubes by passing them through a draw-plate. The wire is then given to the glass blowers, who bend it into a loop and insert it in a small glass tube which, in the manufacture of these lamps, is of a prepared black glass, which is found to make a closer union with the glass of the globe itself when joined together by fusion than if ordinary white glass is employed.

The small glass tube containing the platinum wires is then heated in the blowpipe flame and the ends of the wires having the small tubes in them are drawn apart, thus changing the stilt or stem from a round tube into a flattened V-shaped form with the wires intimately embedded therein, thus enabling an air-tight joint to be made with the globe.

We can now return to the filament which is mounted in the above described stem by inserting its ends in the tubes of the platinum wire formed to receive them, which are then compressed around the ends of the filament and the junctions electrically welded together, thus forming a perfect mechanical and electrical union between the two.

The mounted filament is now subjected to a further electrical treatment peculiar to this lamp, which gives to the filament the remarkable property claimed for it, of increasing in light-giving properties after the first 100 hours' run, instead of deteriorating, as is often the case.

The mounted filament is now complete and ready for inserting in the globe; but before this can be done, the globe itself must receive some attention. The globes are blown, in the case of the 16 c. p. lamps, and moulded, when required for larger size lamps, in a pear shape having a long neck of a width sufficient to allow of the insertion of the filament. The rounded portion of the globe is, at this stage, perfectly smooth, not having the small excresence or point seen on the completed lamp. The first thing to do is to "tubulate" the globe, for exhausting, which is accomplished by fusing a straight piece of glass tube about three inches long to the centre of the rounded portion of the globe, for the purpose of attaching the lamp to the mercury pump. The globe is now ready to receive the mounted filament. The platinum loop on the mount being first cut, so as to form two ends, the whole is then placed inside the globe, through the neck, which is thereupon heated and melted off at the required length, leaving the stem of the filament sealed to, and in the centre of, the neck of the globe. Copper wires are next attached to the platinum ends and the neck of the globe is again heated and the filament pushed down with the aid of the copper wires as far in the globe as desired, thus, so to speak, turning over a portion of the neck into the lamp.

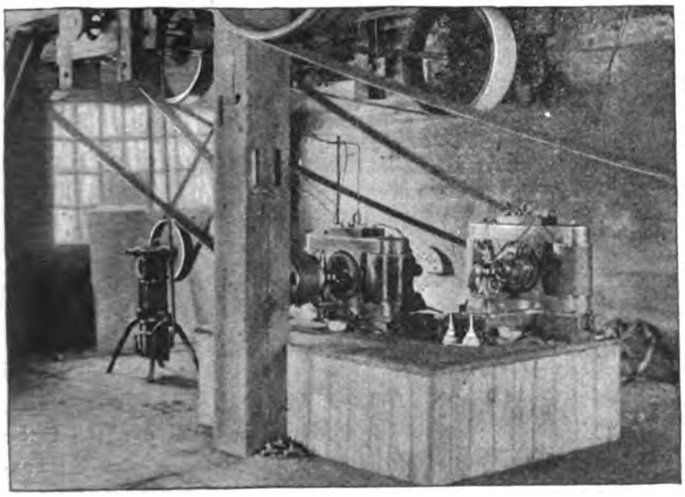
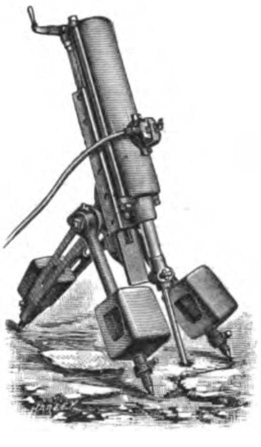


Fig 3.—Dynamo Room; Standard Lamp Factory.

This completes the glass blower's work and the lamp is now given to the pumpers for exhaustion and is placed on the pump by means of the glass tube referred to above, and exhausted till a perfect vacuum is attained. This having been secured, the lamp is sealed off by means of a small blow pipe flame at the point of union of the glass tube and the rounded portion of the globe, leaving the familiar point or tip, above mentioned. All that now remains to do is to test the lamps for candle power and to detect the presence of any fault or defect in the lamp, should it exist, which is done by giving them a three hours' run, after which they are placed in the various kinds of lamp bases for use in sockets of different systems, sorted according to voltage, candle power and style of base, and placed in racks ready for packing and shipment.

This completes the necessary cycle of arrangements to be gone through in the production of what, when finished, appears to be such a simple piece of apparatus. It is unnecessary to state that throughout these processes the most delicate and pain's-taking care is taken to prevent the presence of any defect and produce for the market a highly efficient, durable and successful lamp. The whole manufacture of these lamps is conducted under the supervision of Messrs. Oppermann, to whose inventive genius the various special methods and devices used are due.

THE EDISON ELECTRIC PERCUSSION DRILL.



Edison Percussion Drill.

The Edison General Electric Company gave an exhibition of their electric percussion drill recently in Quincy, which was attended by a large number of quarry owners in Massachusetts, as well as by a large number of mine owners from Boston and Canada. The result of the exhibition was very satisfactory indeed, and the general opinion expressed by parties well versed in such matters was, that the electric percussion drill is far ahead of the steam or compressed air drill. Two steam drills, working in the same quarry gave an excellent chance for comparison.

Although the stone in Quincy is exceptionally hard, the electric percussion drill was able to drill a hole 1½ inches diameter, at an average rate of 2¾ inches per minute, with an expenditure of power less than 4 h. p. delivered to the generator. At one time the rate of drilling was as high as 4 inches per minute.

Among the special features brought out by this exhibition were the extreme ease with which the power could be transmitted to the drill from the generating station, and the great simplicity of the machine itself. The wires were taken from the edge of the quarry direct to the place where the drill was at work, without any further intermediate supports being needed. The distance along the wires was 350 feet, the vertical distance between the drill and the edge of the quarry, 100 feet.

For the purpose of exhibiting the ease with which the machine could be taken to pieces, and any defective parts replaced by others held in reserve, the drill was several times opened and entirely taken apart—the time required for this being less than three-quarters of an hour. It must be borne in mind that to do the same thing with a steam or compressed air drill, would require a very much longer time, owing to the fact that the different parts have to fit well together, and the joints have to be well packed. In case of accident to the last mentioned drills, they would have to be repaired by a competent mechanic, and it would be some time before they could again be used; whereas, with the electric drill, it was shown that any accident to any of its parts could be remedied within three-quarters of an hour by simply taking out a defective part and dropping in another one held in reserve, as the parts of the electric percussion drill are made according to standard sizes and are interchangeable.

LIGHTING THE "PRINCESS ALICE."

The electric lighting of H. S. H. the Prince of Monaco's yacht, "Princess Alice," has been placed in the hands of Woodhouse & Rawson United, Limited, Electrical and Mechanical Engineers, 88 Queen Victoria street, London. The engine is of the single cylinder vertical type running at from 200 to 250 revolutions per minute, according to the E. M. F. required, with a steam pressure of 150 lbs., and is provided with an extended bed plate for receiving the dynamo which is coupled direct to the engine, and gives, when running at 250 revs. per minute, current for 100-16 c.p. lamps at an E. M. F. of 135 volts, this particular E. M. F. being provided to allow of charging the accumulators. The number of lamps installed throughout the yacht will be about 100, the fittings being of an elaborate description, and designed especially for this installation. The whole of the arrangements are not yet completed, but in all probability there will be provided a set of accumulators, a projector, and also a powerful submarine arc lamp for carrying on scientific observations at night.

Mr. Wm. H. Cull, the superintendent and electrician of the Albany Railway, Albany, N. Y., has resigned his position to take effect May 1, 1891. Mr. Cull has had charge of the electrical department of this road since it began operations last April. In fact he constructed a large portion of it. It has been one of the most successful electrical railways in this country. Mr. Cull has, we understand, not yet made any engagement.

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Vol. XI. NEW YORK, APRIL 8, 1891. No. 158.

I have ever loved to dwell upon the very words in which great truths are given to the world, for thus the inspiration of the discoverer infuses itself insensibly into the soul of the reader, and leaves ineffaceable impressions of the simplicity, the dignity, and the comprehensiveness of science.—Alfred M. Mayer.

THE UTILIZATION OF WATER-POWERS.

VARIOUS articles in this issue bear upon the important question of the electrical utilization of water power. The leading contribution on the subject is the admirable paper read before the Buffalo Electrical Society, by Mr. Madison Buell, who has made a masterly compilation of the data of work in this line and presents his results in a most attractive and instructive form. Another article is that descriptive of the work proposed at Lauffen, on the Neckar, in the transmission of 300 h. p. A third article deals with the installation for the extensive utilization of water power electrically at Olympia, Wash., and a fourth gives some details of the work already begun at Joplin, Mo., where power and light are to be distributed over a wide area in a mining district.

It will be observed that Mr. Buell looks for the almost complete replacement of steam engines by turbines through the use of electricity. While we share many of his opinions and much of his enthusiasm on the task that water power has before it, we cannot go quite so far as he does. On the contrary, we believe that for an indefinite time to come the use of steam engines will increase. The engines will grow in size and, by compounding and condensing methods, be made more and more economical of fuel or water. The great change that does lie before us is that instead of having a large number of separate steam plants we shall have central steam plants whose power will be cheaply and effectively distributed through the agency of electricity. This process has already begun, and the extension of motor service has the beneficial effect also of making the production of current for lighting cheaper too.

In a word, the rapid increase in water-power plants will not greatly affect, or be affected by, the existence of steam plants. Any change that comes will not be in the direction of abolishing a single agency we now enjoy, but rather by way of limiting each to the work for which it possesses undeniable advantages of economy, efficiency and availability. Moreover, while the water-powers still to be brought under the yoke represent an enormous total waste, the net power utilizable will be but a fraction of the sum. Thus Niagara takes the drainage of an area of nearly 250,000 square miles, but it is only a small part of Niagara that even the most sanguine engineer expects to put in harness.

It seems well to make these remarks in passing, as it is often said by way of criticism, that electrical engineers in dealing with these questions are too fond of looking upon all the possibilites as actual achievements, and very slow to a admit the existence of any insurmountable difficulties. If this be a fault, it is at least a pardonable one, and certainly Mr. Buell has made a magnificent showing of hard, honest and successful work in this field, not only in America, but in Europe and other parts of the world.

As demonstrating the advanced state of the art of the electric transmission of water-power as compared with its condition less than ten years ago, we need only refer again to the experiments which have just concluded, and which constitute the preliminary tests of the transmission plant to be installed in connection with the Frankfort electrical exhibition to be held this year. It will be recalled that in 1882, Marcel Deprez carried out his famous experiment of transmitting the power of a waterfall at Miesbach to Munich, a distance of 37 miles. In that experiment, which is justly looked upon as the one which finally settled the question of the practicability of long distance power transmission, the potentials employed barely exceeded 1,800 volts, while the actual power obtained from the motor at the distant end did not exceed ½ h. p. We recall distinctly the objections raised at that time to the success of the system of transmission, among them being that of the inability of the armature to withstand successfully pressures exceeding very much the one employed. At that time, however, the alternating current had scarcely been hinted at, much less put in actual practice. To-day, however, the converter and alternating machine allow us to use potentials twenty times as great as that deemed safe only 10 years ago, by confining such high potentials to the outside circuits, and employing in the machine at the station the low tension current of conversion. Instead of ½ h. p. transmitted for 37 miles, it is contemplated to transmit 300 h. p. over 115 miles, and over a wire ⅙ of an inch in diameter, and at a potential of 30,000 volts. With these new methods at our command, the problem of economic transmission of water-powers takes on an entirely new complexion, and where once the cost of conductors acted as a deterrent to the undertaking of such work, the present methods relegate their consideration to an inferior position. The success of the proposed plant at Frankfort would, we are certain, open up a new era in electric power transmission for long distances, and at last lead to the realization of the predictions made 10 years ago, that not only Niagara but every other available water-power would be utilized through the medium of electricity.

STATISTICS OF THE TELEPHONE INDUSTRY.

THE annual report of the American Bell Telephone Co. presented last week, and now summarised in our columns, shows a large and steady growth in the industry. The earnings during 1890 reached the substantial figure of $4,375,290 as compared with a little over $4,000,000 in 1889. Out of this sum, not less than $2,213,913 was paid out in regular and extra dividends, representing the earning and profit yielding capacity of the capital stock of $12,500,000; while the large amount of $600,000 was carried to reserve for general depreciation, and an additional $55,500 for depreciation on instruments.

The other data contained in the report shows 483,790 instruments under rental, a gain of nearly 40,000 over 1889, while the number of connections reached 450,000,000, or about 3 per day per subscriber. It goes without saying that the return of wire mileage indicates a large addition to the number of underground circuits, for the telephone people have been most exemplary in their endeavor to meet the popular will in this difficult matter. The company through its Long Distance sub-organization has also been able to make remarkable progress in connecting together the various telephonic centres and systems; and its highly intelligent and creditable work in this new department is already bearing good fruit, not only in securing dividends on the investment but in giving increased facilities of communication to the public.

Such a report as that above referred to is likely to add to the unusual interest now attaching to the telephone situation, and its imposing totals of earnings and profits will make many mouths water. It is needless to point out that in a year or two this great system, built up with so much care and effort and ability, may be subjected to considerable strain. The figures indicate, however, a strength of organization and powers of endurance that bid defiance to assault, even if there were not left a single patent as a bulwark of protection.

BRIDGING TELEPHONE BELLS.

ALTHOUGH we have already described, in a general way, the important improvements introduced by Mr. J. J. Carty, in connection with telephone lines to which a number of subscribers are connected, the issuance of a patent on this valuable invention now permits us to give in detail the arrangements adopted. Mr. Carty's improvement, it will be noted, is one the very simplicity of which is its most striking feature. In its nature, indeed, it resembles very much the radical difference which exists between the operation of lamps in series and in parallel. In the one case we have the resistance in the line, as well as the retardation, equal to the sum of all the bells and transmitters in the line, while by bridging all the bells as shunts around the transmitters, not only is their resistance practically eliminated, but their retarding effect is also cut down to a very large extent. This has been sufficiently demonstrated by actual practice. The far reaching nature of this invention is not only due to the fact that it improves the quality of telephonic transmission, but also makes it possible to reduce the number of lines required for telephonic work, as in a number of cases a calling circuit has been necessary to avoid the evil effects experienced in operation. It is not improbable that Mr. Carty's system will become general for telephone service, both local and long distance.

ALTERNATE CURRENT WORKING.

AMONG the many valuable hints and suggestions contained in Mr. James Swinburne's paper, which we conclude in this issue, are several that just at the present moment are deserving of special attention. It seems to us that the mode of distribution, now in vogue, of supplying the high potential direct to the distributing conductors from machines delivering high E. M. F., is certainly open to objections, as pointed out by Mr. Swinburne. There appears to be no good reason why low potential machines should not be employed in connection with station transformers so that the high tensions are confined entirely to the outside circuits. This arrangement, it will be noted, has been adopted in the power proposed transmission between Lauffen and Frankfort, which we describe elsewhere in this issue. In the latter case it was considered more as a method of economy and safety in operating the alternating generators. But in a city distributing system, another more important factor enters into the calculation, namely, the greater economy of distribution to the district directly surrounding the station. Evidently, there is no advantage in employing converters where direct distribution can be economically carried out; hence, with low tension machines at the station which could supply current for short distances direct, or through converters for greater distances, uniformity in apparatus and economy can, we think be obtained, notwithstanding the introduction of an additional conversion in the latter case.

Mr. Swinburne also favors, and for good reasons, the method of distributing to local districts from single large transformers feeding low tension mains, instead of supplying each house with its own transformers. The important part also which the condenser may yet play in alternate current distribution makes it worth the while of inventors and experimenters to work in the direction of obtaining a cheap and durable type of this apparatus.

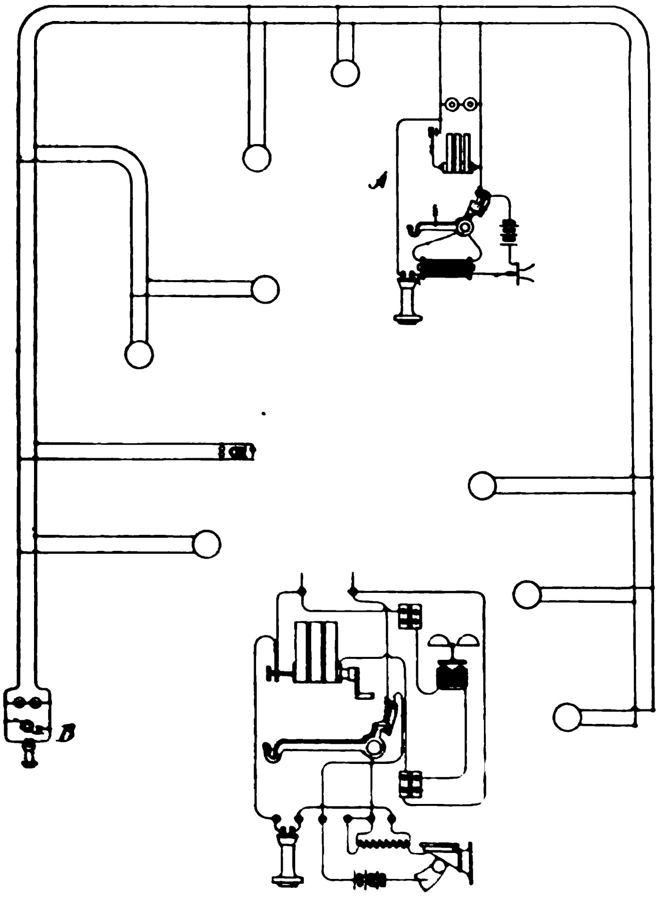
A Dust Proof Contact.

OF the many annoyances which the electrician is subjected to in the operation of the instruments and apparatus which he employs, that caused by the accumulation of dust is probable the most general and ever present. A simple device, therefore, to obviate this inconvenience will be recognized as a valuable adjunct to not a few electrical appliances, and as such the simple little protector designed by Mr. Richard Varley, Jr., and described in another column will be noted with interest. By enclosing the contacts in a dust proof flexible case, the inventor excludes dust and moisture without interfering with the motion of the contacts.

CARTY'S "BRIDGING BELLS" FOR TELEPHONES.

No better evidence of the efforts which are constantly being made by the telephone companies of this country, to improve and extend the usefulness of the telephone can be found, than the important advances which have recently been made by the men engaged in the technical branch of the business. We have at various times referred to the "Bridging Bell" system of Mr. J. J. Carty, which has come into extensive use since the last Telephone Convention, and are now enabled to give more complete details of this remarkably simple and effective arrangement, which has just been patented to Mr. Carty. By this arrangement it is now possible to connect a large number of subscribers to a single circuit without interfering with the clearness of the articulation.

Mr. Carty's arrangement is illustrated in the accompanying diagram, Fig. 1, which shows a metallic circuit line containing eleven stations connected in multiple arc. At A is shown in detail the connections of a station, and at B is a schematic representation of a station circuit when the telephone is off the hook.



FIGS. 1 AND 2.—CARTY'S BRIDGING BELL ARRANGEMENT.

Fig. 2 represents in detail the circuits of the bell, which are probably the simplest which have yet devised. The magnet coils are permanently connected to line and the lower contact of the automatic hook is entirely dispensed with. This bell is applicable alike to grounded and metallic circuits and is in successful use on both classes of lines.

Apart from a number of mechanical improvements and general superiority of design, the distinctive feature of this bell is the putting of each bell magnet in multiple arc with its own generator instead of in series with it, as has heretofore been the case. The bell magnet itself is of high inductance, and is so designed as to be absolutely without any bad effect on the telephone current.

The "bridging bell" possesses so many points of superiority that there is little doubt that it will replace all other kinds at an early day.

THE ELECTRICAL UTILIZATION OF WATER POWER.[1]

BY MADISON BUELL.

THE paper began with an eloquent account of the formation of water in the early days of the world's existence, and showed how at least three-quarters of the surface of the globe are covered with it, part of it being kept in motion by the tides and part through the agency of clouds and springs. These two forces embodied in water, Mr. Buell said, would eventually dispense with the burning of coal for power and crowd the steam engine out of employment. "The energy of the tidal wave, the rapid river, and mighty cataracts transformed into electrical energy is a branch of electrical science that is going to revolutionize the industries of the world."

As to the power represented in the flow of water, Mr. Buell pointed out that not less than 21,446,210 cubic feet pass over the lip of Niagara every minute, while the flowing of nine rivers that empty into the Pacific, represents 900,000,000 h. p. every time it descends one foot. On the other hand, the United States has steam engines representing 7,500,000 h. p.; England, 7,000,000; Germany, 4,500,000; France, 3,000,000; and Austro-Hungary, 1,500,000. These figures do not include the 3,000,000 h. p. of 105,000 locomotives. Add this to the other motive power, and it will be found, remarked Mr. Buell, that we have on this globe, engines equal to 46,000,000 h. p. These engines do the work of 1,000,000,000 men, or twice the working population of the earth. It is the place of water power utilized electrically to supplement and replace these engines, and it would therefore be worth while to see how far the revolution has already gone.

Mr. Buell with the aid of an imaginary camera then took his audience through a picture gallery of electrical water power plants.

"Let us press the button, and see what the camera reveals. The negative is clear and well defined. The picture is an inspiring one and full of grand significance, to an electrical engineer. It shows that the ethereal vibrations of the sun, are melting the Alpine snows, and the water in a never failing stream is revolving the turbine wheels, which in its turn, whirl the dynamo armature, and its electrical energy is conveyed miles away over a copper thread to a motor of a woolen manufactory of over 36,000 spindles. Another movement of the ethereal camera, another pressure of the 'button' and we have another negative, showing hundreds of laborers erecting a large plant at Rheinfelder, on the Rhine, consisting of 20 turbine wheels coupled direct to dynamos of 500,000 watts. The energy is to be transmitted to various industrial centres within a radius of 15 miles.

"Here is one showing a recent achievement in modern engineering, in an electric mountain railway at Burgenstock, near Lucerne, Switzerland. The Burgenstock is almost perpendicular; from the shore of Lake Lucerne it is 1,330 feet, and it is 2,800 feet above the level of the sea. The total length of the road is nearly a mile, operated by two dynamos of 25 h. p., worked by a water wheel of 125 h. p.

"The next negative shows a peculiar view between Pazzala and Lugano, in Italy. At the right of the picture, we see a large waterfall, which supplies the water conducted through iron pipes to the dynamo room, where two Girard turbines of 300 h. p. each run two dynamos, one for continuous and the other for alternating currents, the former working the tramway motors, the latter supplying nearly 2,000 16 c. p. lamps at the hotel, and in private buildings. The tramway is a double track one of over a mile in length and is worked by a cable, supported on wooden rollers, one branch of the cable is attached to the ascending, and the other to the descending car.

"Here is a picture of the town of Trente, Austria. A large water-fall furnishes the power sufficient to supply electrical energy to all the mills, hotels, and small industries; it is also furnished to the houses of the poorest inhabitant of the town, not only power, but illumination. The next view is an Irish scene of the Giant's Causeway Electric Railway in the north of Ireland, showing 2 Alcott turbines driving dynamos which furnish power for the motors of the railway; the latter is eight miles long.

"The camera is full of splendid negatives, pictures mostly of electrical plants in Switzerland. Counting them, I find nearly 200 electrical power stations operated by water-power, and it would be too tedious to give full descriptions of each one, especially so, when I desire to take hurried views all over the world.

"The next picture represents a hotel 'The Bernina' at Samaden, Switzerland. It is lighted by electricity, the power being supplied by a waterfall some distance away. As the power is not required during the day for illumination, the current is utilized for cooking, by heating German silver resistance coils. The cooking operations for the hotel are all satisfactorily performed by this method. While I am putting in a new set of plates into the ethereal camera, I will say that it is a well-known fact that Switzerland is disadvantageously situated as a manufacturing country; although it is supplied with an almost unlimited number of the finest water powers in the world, situated upon unfailing streams, fed by the melting of Alpine snows, yet these are located in inaccessible valleys and ravines where economical transportation of heavy products is impossible. Railroad lines are in the main valleys at too great a distance from the water powers, to render them of much value. Steam power is expensive as there are no coal mines, and the coal must be brought many hundred miles up heavy grades. This is so costly that the Swiss manufacturers have been unable to compete with those more favorably situated in conntries in close proximity to the iron and coal districts. Swiss industries heretofore have been on this account confined to the lighter and more delicate varieties. The recent introduction of methods of transporting and distributing power by electricity is rapidly changing this state of affairs, and in a few years Switzerland will become one of the foremost countries of Europe in all grades of heavy machinery."

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[1] Abstract of a paper read before the Buffalo Electrical Society, April 6, 1891.

"Even on the 'dark continent' the electrical energy sheds its ethereal light, for the first negative is an African view. It is the Forbes Reef Gold Mining Co. of Transvaal, South Africa. The primal source of power is a water-fall three miles from the mine, operating Pelton water wheels coupled direct to Edison dynamos, each dynamo having a capacity of 67 h. p. Over 200 h. p. is transmitted to a distance of four miles. The efficiency of the entire systems from the Pelton wheel pulleys, to the mining machine at the distance end is over 70 per cent. That is, over 70 per cent. of the energy delivered from the water wheel pulleys at the power station is given off at the motor pulleys for work. Another picture in South Africa reveals the fact, that the Kimberly Mines are also lighted and worked in the same manner."

"Selecting another plate, the scene is changed to Oregon. We have a splendid view of the falls at Willamette. The energy of the water is here converted into electrical energy, and transmitted a distance of 12 miles to Portland."

"A view in South America, shows a cataract of the Juncalillo River, having a fall of 600 feet, supplying water through steel pipes a mile to Juncal station, where it sets in motion 10 water wheels, each of 80 h. p., connected to dynamos, the energy of which is used in driving motors for boring through the Andes mountains, to provide for a new railway connecting the Argentine Republic with Chili."

"Now we have a view of Coronado Beach, Cal., where they are endeavoring to utilize the rotatory motion of the earth by converting the waves of the ocean into the motive power. The energy is transmitted through a cable, and experiments have demonstrated the entire practicability of the scheme."

"Here is another revelation. It is only one of the many forerunners that augurs success to the Niagara scheme. This is a a tunnel 16 feet by 12 feet and 2½ miles long, cut through the mountain from Feather River to Big Bend Tunnel Camp, Butte Co., California. A permanent dam built across the river just below the head of the tunnel diverts the whole stream into the tunnel, and a canal two miles long, extending from the other end of the tunnel, gives a fall of 800 feet, turning powerful Pelton water-wheels driving Edison dynamos. The working E. M. F. is 1,000 volts; the conductors are double metallic, and extend 18 miles, delivering electrical energy at 14 points in the circuit, where power is required for winding, pumping, etc. From 10 to 20 Sprague motors, varying from 5 to 50 h. p., are worked by branch conductors from these various stations, the potential varying at the motors from 500 to 700 volts."

"Steam in Nevada is expensive on account of the scarcity of fuel; water is also an expensive commodity, as in this case we see that it is brought from the summit of the Sierras, in pipes, a distance of thirty mile, to the Comstock mines. The Sutro Tunnel at this place affords an outlet for this water 1,700 feet below the surface of the earth. It is the utilization of this pressure that gives an illustration of an amazing exhibition of power. Six of the world renowned Pelton water-wheels are used for running the dynamos in a rocky chamber in the tunnel. From the dynamo room, wires are carried up to the motor room at the top of the shaft, there being a mile in each circuit. The water-wheels attached to the dynamos are 40 inches in diameter and run at 900 revolutions. They are made of phosphor-bronze in order to stand the enormous speed the velocity of the water would give them, when running without load, which would be 1800 revolutions, giving the periphery of the wheel a speed of 18,864 feet, or more than 8-½ miles a minute, the water flowing from the nozzle at a volocity of 19,260 feet a minute. You may get some idea of such force issuing from the nozzle of the pipes, when I state to you that I can see a group of visitors looking at them, with wonder expressed all over their faces, while one of the laborers in the mine wields powerful blows with a sledge hammer upon the stream of water, and the hammer rebounds as though the water were a bar of steel. The compact arrangement of combined dynamos and water-wheels, and the noiseless operation of the latter, make it almost impossible to realize the amount of power developed by the swiftly revolving armature."

"In Colorado there is water power enough to furnish light and power for the whole state. The thriving town of 7,000 inhabitants, Aspen, fairly vibrates with ethereal manifestations. Eight Pelton water-wheels running 1,000 revolutions, under a head of 820 feet, with a maximum of capacity of 174 h. p. each, aggregating some 1,400 h. p., revolve the armatures of as many dynamos, furnishing the current for 120 arc lights of 2,000 c. p. each, and 2,000, 16 c. p. incandescent lights. These lights are distributed over an area of over four square miles, and are used for lighting the streets of the town, hotels, stores and residences. Greenwood Springs is also in a blaze of electric light. Mills, pumps, hoists and tramways are successfully run miles away from the power station. During the winter months the Pelton wheels though incased in ice for weeks together, keep spinning away without cessation."

"The next negative gives evidence of the progress of the Japanese people. I can make out five water-wheels, having an aggregate capacity of nearly 600 h. p., running dynamos; the electrical energy being transmitted to the city of Kioto, for general manufacturing purposes. The water is conveyed to the wheels through 2,000 feet of sheet iron pipes, and the supply is obtained from the Kioto-Fu-Che canal."

"Views all over California and the Pacific region, show the progress already made in the transmission of electrical energy by means of water power. Away up on top of the mountains nestled in among the clouds, 2,000 feet above Red Cliff, in the very heart of Eagle River Canon, I behold the town of Gilman, more than 11,000 feet above the sea level. Looking across from Gilman on the other side of the great canon, there is a mountain stream called Fall River, rising in the mountain of the Holy Cross, and I can almost hear its roar, as it crashes and tumbles down and over the rocks and enters the Eagle River at the bottom of the cañon. This water is brought by a pipe line into the mines, and the fall is equal to 500 feet perpendicular, and its energy drives the dynamos, the electrical energy being conveyed to all parts of the richest mines of gold and silver in Colorado.

"Swinging the camera to the state of Maine, the eye takes in the great Penobscot river, the largest in Maine, draining over 7,400 square miles, a region as large as the state of Massachusetts, for 12 miles from Oldtown to Bangor the river falls over 90 feet, giving several of the finest water-powers in the world. At a place called Veazie, which I see is situated four miles above Bangor, there is an electrical plant in the course of construction, which, when completed, will be one of the largest in the world. Fifteen water-wheels of 150 h. p. each, will be placed in this plant, so arranged as to run separate or in groups. Six of the wheels are already in operation. The plant will supply lights and power for the cities of Bangor and Brewer. The water-power at Veazie is immense; the flow of the river at this point at low water. is 146,000 cubic feet per minute, affording 2,500 h. p. with a nine foot head. A portion of this negative shows the town of Dover on the Salmon Falls river, on the division line of the state of Maine and New Hampshire. Light and power are not only furnished to Dover, but to several distant towns. Power is also furnished to a street railway seven miles in length. The water-wheel has a capacity of 500 h. p.

"I find to the right of this negative a scene in the Commune of Millas, Western Pyrenees." It shows an area of 1,500 acres, devoted to wine-vintage. A stream of water furnishes power for lifting and driving purposes, driving dynamos and motors, and furnishing current for 200 incandescent lamps distributed in the houses within the area named. The length of wire used in connecting the various buildings in this system is 62 miles.

"Pointing the camera toward Lake Superior I see extensive preparations are being made to utilize the waters of that lake, which fall at the Sault, about 80 feet to the level of Lake Huron. The water-power at Sault Ste. Marie is estimated to have a velocity and volume of 122,000 feet per second, equivalent to 236,000 h. p. A tail race five miles long on the Canadian side and a canal five miles long on the American side are to be constructed. The canals will be each 1,000 feet wide, the widest in the world. Blast furnaces, shipyards, paper mills, pulp mills, flour mills and other industries will all be furnished."

Mr. Buell, then speaking of tidal power, said he saw no good reason why that of the East river, between New York and Brooklyn should not be utilized for the two cities. To show how vast is the energy of natural forces, Mr. Buell proposed to consider a storm traveling 60 miles an hour extending over 500 miles of country:

One of our storms exerted a pressure of 80 lbs. per square foot or ½ lb. per square inch, and traveled at the rate of sixty-six miles per hour. "There are in a square mile 27,878,400 square feet, or 4,014,489,000 square inches. If the pressure was half a mile in vertical height, we have for each mile in width of the track of the storm, an area of 2,007,244,800 square inches upon which the storm acted with a pressure of ½ lb. and with a speed of 5,800 feet per minute.

To find the horse-power we have the formula:

$$\frac{\text{Area in inches} \times \text{pressure in lbs.} \times \text{speed in feet per minute.}}{33{,}000.}$$

The calculation becomes:

$$\frac{2{,}007{,}244{,}800 \text{ square inches} \times \tfrac{1}{2} \text{ lb. pressure} \times 5{,}800 \text{ feet.}}{88{,}000.}$$

the result is 70,557,700 horse-power for each mile breadth of the storm.

To produce the same horse-power, with improved engines consuming but 2 lbs. of coal per hour per horse-power, would take 63,000 gross tons of coal.

Assuming the track of the storm to be 500 miles wide, the hourly consumption of coal to generate an equal power would be at least 31,500,000 gross tons, or one and a quarter times the annual product of the entire anthracite coal region.

Coming back to water-power Mr. Buell said:

"Upon the beautiful Spokane river I can see the city of Spokane Falls now one of the prominent cities of the West. In 1885, when the present city was a mere town of a few thousand inhabitants, there was a little wooden shed erected in which there was placed an electrical plant, capable of furnishing electrical energy for twelve arc lights and less than three hundred incandescents. One water-wheel furnished the power to run the dynamo and the whole affair had, up to a short time ago, a varied and checkered career. Now consider the contrast. The power I see in Spokane Falls, compared with the water-power so far developed in any country, is the peer of them all. As the development proceeds and its immense force made fully available, its financial value will be stupendous; to replace the power, which this negative shows, by steam, would constitute the outlay of $10,000 per day for fuel alone. An idea of its actual money value may be obtained, when it is stated that the cost of producing one horse-power per year by steam is $50, and the lowest total power available at Spokane Falls is 30,000, the amount of wealth annually added to that city on the basis of $50 a horse-power per year would be $1,500,000. The power station now seen at the same place where the little wooden shed stood in 1885, is one of the greatest in the world. It is estimated at three thousand horse-power and distributes electrical energy for 12,000 incandescent lights and 1,200 arc lights, besides furnishing it for nearly all classes of industries. No city in this country can show, for its size, so great an employment of electrical energy in everyday life.

"The experiment of transmitting three hundred horse-power electrically from Lauffen on the Neckar to the Frankfort exhibition, a distance of over 100 miles, will be tried the coming summer. The result of preliminary experiments already made, indicate that the proposed transmission will be a complete success. I have seen an electric arc light produced in Buffalo, where the energy to make such a light came from a point beyond Syracuse, N. Y., over a No. 8 galvanized iron wire, a distance of over a hundred and fifty miles."

Mr. Buell now came to a consideration of the great work proposed at Niagara Falls, and said:

"Let us now take a look at the present hydraulic canal, which even now is considered a work of great importance, though soon to be abandoned. It was constructed in 1855, and is, as you see, cut through solid rock across the peninsular on which the village is built. The canal is nearly a mile long, and was originally planned to be 100 feet wide and ten feet deep. This canal lay idle for nearly a quarter of a century, until one of our citizens opened up its immense facilities. In 1878 there was only one water-wheel on the canal, to-day we see a large number of buildings along the bank of the river using an aggregate of nearly 8,000 h. p. The Brush Electric Light and Power Co. furnish light not only for Niagara Falls, but for Suspension Bridge. The wires of the company also cross the river into Canada and light Niagara Falls, Ontario, making a circuit of several miles along the bank of the river on each side.

"The idea of the tunnel at Niagara Falls originated with the late Thomas Evershed. The tunnel or tail race is to extend from the surface of the water level below the Falls to a point on the Niagara river above the Falls. It is to be connected with the river by means of short surface canals, wheel pits and cross tunnels. The power expected to be produced by the capacity of the tunnel will be equal to the water-power of Lawrence, Lowell, Holyoke, Turner's Falls, Manchester, Bellow's Falls, Lewiston, Me., Oswego, Patterson, Augusta, Ga., Minneapolis, Rochester and Lockport combined. The method of using the power is the same as that in operation upon the Hydraulic Canal. Though the principle is the same, there is a difference in the manner of obtaining the water. At the Hydraulic Canal there is one long surface canal, a canal basin or reservoir, wheel pits and short tail races to the adjacent high bank of the river. In the case of the tunnel, the Niagara river is the basin or reservoir, directly connected by short surface canals, wheel pits and cross tunnels, with one great tunnel or tail race, nearly two miles in length, which carries the water from the wheels to the Niagara river below the Falls. The tunnel is to be of horseshoe shape, having a capacity equal to a circle of twenty-five feet in diameter, extending through the solid rock from the water level below the Falls to the upper river above the cataract, a distance of one mile. From this point the tunnel is to continue parallel with the shore of the river one and a half miles, at an average depth of 160 feet below ground and about 400 feet from the river, with which it is to be connected by means of surface conduits, through which the water from the river enters, and is drawn through the shafts and wheel pits into the great tunnel below. The plans adopted will develop 120,000 horse-power.

* * * * * * * * *

"Crossing now over the new bridge below the cataract into Ontario, we learn from reliable sources that the scheme for the electrical utilization of the Canadian Falls is well under way. The Pelton Water Wheel Company, of San Francisco, Cal. have sent to the Niagara Falls commission at London, England, an estimate of the wheels and appurtenances for one block of twenty thousand horse-power. For an electric section, four wheels to develop 8,000 horse-power; for a compressed air section, one wheel of 4,000 horse-power, and for the hydraulic or pumping section two wheels of 4,000 horse-power. The scheme, estimates and adaptation of Pelton wheels of such enormous power involved a mass of engineering work, creditable alike to all concerned in the labor.

"The Pelton wheel is what is termed a tangential wheel, and is considered of great simplicity of construction and efficiency. The diameter and consequent axial speed of tangential wheels, of the Pelton type are such as to adapt them to the requirements in any case, so that direct connection can be made to dynamos, etc. This method has been adapted by the Pelton Water Wheel Company in their plans for the Niagara plant, and the wheels are to suit present or future stipulations of the power company as to speed. The Pelton wheel employs round jets, impinging on peculiarly formed vanes, constituting marked advantages, it is claimed, over wheels of the Girard type. The wheels are not well known in the East, for the reason that the circumstances which led to their use and development in California do not exist elsewhere, *i. e.*, working heads of from 100 to 1,600 feet, and for the reason that every stream is torrential until it reaches the plains. The company furnishing the Pelton wheels, claim that they can arranging a system so that a wheel can be made to develop at pleasure 1,000 to 5,000 horse-power without impairing its relative efficiency, and that such changes can be made in a moment's time, and when the wheels are in operation. The two plans for the electrical utilization of the water of the Niagara, it will be seen are totally different. Mr. Ferranti, the engineer of the Power Company organized to erect works on the Canadian side of the river has a preference for the Pelton wheel and is investigating its merits. I am reliably informed that the London commissioners have given a prize premium to the Pelton Co., for their plans in connection with the Norwalk Compressor Co."

TRANSFORMER DISTRIBUTION.[1]

(*Concluded.*)

BY J. SWINBURNE.

A machine without friction may be imagined, and when its field magnets are separately excited, so as to give an electromotive force exactly equal to that of the mains when it is connected so as to be in step, it runs as a motor taking no current. At each instant the electromotive force of the machine is exactly equal to the electromotive force of the mains, so no current passes. On putting on some load the machine begins to lag. As soon as the machine lags, a current passes through the armature. The current due to the difference of two equal alternating electromotive forces is not in step with either of them. This is shown in Fig. 6, where two pressure curves are drawn a little out of step. The current through resistance is proportional to the shaded parts. If the electromotive force of the machine were still the same as that of the mains, it would still develop no power as a motor, because at some parts of the period it would be supplying power to the mains, and at other parts the mains would be supplying power to the armature; for at any instant the armature current would be equal to the difference of the two electromotive forces divided by the resistance of the armature. The average current curve is shown in Fig. 7. The electromotive force of the machine does not, however, remain equal to the main electromotive force, merely differing from it in phase, but is decreased by the reaction of the armature current on the field magnets. The average current curve shows that there would be considerable back induction, or many ampere turns tending to weaken the field. This weakening of the field by the armature reaction allows the main also to supply a current against the electromotive force of the machine, so that it acts as a motor, and power can be taken from it.

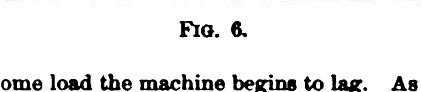

FIG. 6.

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[1] Abstract of a paper read before the London Institute of Electrical Engineers.

If the machine is to be worked as a generator in parallel with the main circuit—that is to say, if it is to supply power to the mains instead of to take it from them—the same reasoning holds good. If the engine supplies just a little too much power, the machine will begin to lead, and an armature current will pass, which will strengthen the fields by reaction, and the machine will at some instants act as a generator, because its electromotive force is now a little higher, as the armature current has strengthened its field. Similarly, if the steam of the engine were completely shut off, the machine would lag until it worked as a motor.

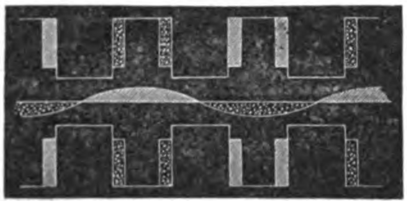

FIG. 7

According to the armature reaction theory, then, whether a machine will run in parallel with others depends on its armature resistance and armature reactions. It must be borne in mind that most machines have cast-iron fields, and though that may make no difference according to the orthodox theory, it does from the armature reaction point of view. If the field magnets do not quickly respond to the armature reactions, it may be difficult or impossible to run machines in parallel.

Another important consideration is the government of the engines. If two engines are working two machines in parallel at 200 revolutions, and one governor is set for 200 and the other for 195 revolutions—if the governors are truly isochronous, one engine and dynamo will supply the whole of the power, and the other will be dragged round idle. The whole question of the government of central stations requires the most careful consideration. I have dealt with the matter at some length elsewhere,[1] but the subject should be very fully thought out in designing stations.

ARRANGEMENT OF STATION.

If the machines are employed in parallel, they may feed into common bars, as in the case of direct currents. If each dirtrict must have its own circuit—which seems to be generally assumed necessary—each circuit may be led away from the common bars with a transformer regulator in it.

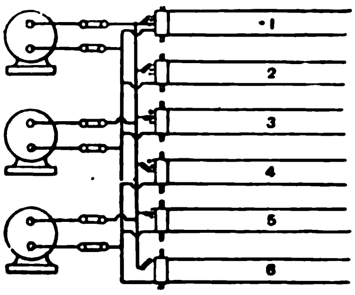

FIG. 8.

It is a great advantage to transform up, and to have all the switches, connections, and measuring instruments on the low-pressure side. The high-pressure circuits may then be arranged to have no metal exposed anywhere. If each district must have its separate circuit, it has its own step-up transformer, with its regulator.

One arrangement is shown in Fig. 8. The dynamos are all in parallel, and wound for 100 volts, the immediate neighborhood of the station being fed direct. Each feeder circuit has a transformer with a variable number of primary turns. A compensated voltmeter is placed on each, and all the attendant has to do is to alter the switches a little occasionally, so as to keep all the instruments' pointers vertical.

TRANSFORMERS.

The loss in the iron in transformers has until lately been very much overlooked; if it is even a small percentage of the full load of the transformer, it mounts up very seriously in station work when the transformers are in circuit all day and all night. The principle of the "Hedgehog" transformer is this: By using an open circuit the iron can be reduced in volume with a given induction. The mean length of the iron part of the magnetic circuit is considerably less, and more copper turns can be wound on without increasing this length much. The additional turns admit of a smaller cross section of core, so that the iron is enormously reduced. The loss in copper is somewhat increased; but, as the loss in copper is only serious at full load, this does not matter.

The exciting current, though larger than in the case of closed circuit transformers, is not a serious matter. The loss in copper is considerably smaller than the loss in iron in most closed-circuit transformers, and, as it varies as the square of the current, it is inappreciable except at full load, which very seldom occurs. The loss in iron is very small, so that the loss per day in ordinary working is very much smaller than in the case of closed-circuit transformers.

Perhaps the best way I can make this clear is by a comparison of actual transformers. As an average size of transformer, one taking 2,000 volts and a frequency of 100, and giving 15 amperes at 100 volts, may be taken, and the working compared.

A gun-metal casting forms the backbone of the transformer. It is cross shape in section, and at one end is spread out to form four legs. It also supports the lower flange, or cheek, of the winding. The four spaces have bundles of soft iron wire put in, so that the core is practically cylindrical. The cross-shaped core has been criticised on the ground that there are Foucault currents generated in it. The least consideration will show that there is no change of induction in it, and therefore no Foucault currents. The iron wire is bound tightly, and the two flanges are slipped into place. A gun-metal "spider" is then screwed to the top. It is finally held on by the eye-bolt, but temporarily a set screw is used. The core is then wound in a special lathe in the usual way. Both the terminal board and the coil flanges gave us a great deal of trouble till we found suitable materials. There is a great need of good insulating materials that will not warp, that will insulate perfectly, and that can be worked.

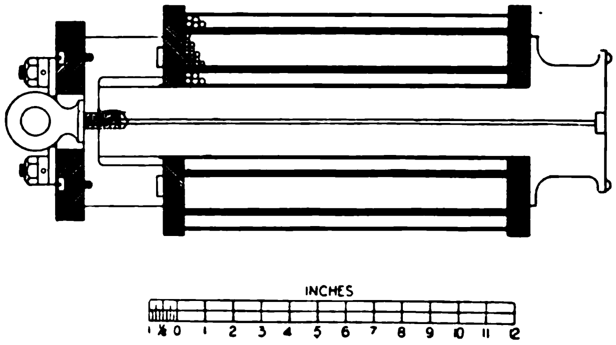

FIG. 9.

The electrical particulars of a 50 8 c. p. lamp transformer are as follows:—

Core, 13.5 in. long, 2.5 in. diameter. In taking the area of the core, allowance must be made for the space occupied by the backbone, and for the loss of room in using round wires. Maximum induction, 4,800. Loss of power in iron, assuming it to be of good quality, 13.5 watts. Primary, 3,920 turns of copper wire, 0.042 in. diameter; resistance, 37 ohms (warm). Secondary, 200 turns, 19/0.042 in.; resistance, 0.098 ohm. Loss of power in primary at full load, due to the transformed current, 21 watts; loss due to the exciting current—0.3 ampere—which is always on, 3.6 watts; loss in secondary at full load, 22 watts. Efficiency at full load, 96.15.

This transformer is shown to scale in Figs. 9 and 10.

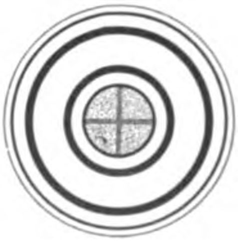

FIG. 10.

Fig. 11 is a scale drawing of a closed-circuit transformer I have taken as representative. The primary is 400 turns of 0.042 in. wire, and the secondary 20 turns of 0.176 in. The loss in copper at full load is 11.3 watts, and the loss in the iron 120 watts. At full load the efficiency is 91.95, or nearly 92 per cent. The diagram (Fig. 12) shows the percentage loss at various loads of the two transformers. The ordinates are percentage loss, and the abscissæ fractions of full load. Curve II. is the "Hedgehog," and IV. is the closed circuit. It will be noticed that the "Hedgehog's" efficiency increases slightly at first, and keeps above 95 per cent. till the load is reduced to one-fifth, and above 90 down to one-tenth load, and it then begins to fall more rapidly. The efficiency of the closed form, however, begins to fall at once, and falls rapidly. In house work the full-load efficiency is a matter of little or no consequence; the loss at very light loads is really important. A house that has a 50-light transformer is wired for 50 lamps, and that is the maximum load. As a rule, there are seldom more than 25 lamps on at any one time, and these are on during the evening only. The average load varies with the time of year and with the class of house. Shops, for instance, have full load for a short time each day; private houses have the lights in the hall and passages on the whole evening, with either the dining or drawing room, and for some time both the dining and drawing rooms are on. It will be a fair average if we take four hours of half-load per day as the output of house transformers. This means an efficiency of 83.3 per cent. for the "Hedgehog," and only 51 per cent. for the closed circuit. In other words, the waste in the closed circuit is between five and six times as great as in the open circuit.

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[1] *Industries*, September, 1890.

There is thus no chance of iron being found good enough to allow the closed circuit form to compete with the open. There is one objection to the "Hedgehog" which must not be passed over, and that is the exciting current. The exciting current in the 50-lighter is 0.31; in the closed circuit it is 0.2; so that it is quite half as much again.

DISTRIBUTION.

Even with the most efficient transformers the house system is a very poor method of distribution. Apart from the question of loss of power, consider the outlay involved in providing each consumer with a high pressure double-pole fuse, a transformer, an automatic device for rendering the whole arrangement safe in case of insulation giving way, perhaps a double-pole main switch, a meter, and a fire-proof safe in which all these things have to be enclosed. In addition to this, it involves a complete high pressure parallel system of distribution, and a network of 2,000-volt underground mains, involving a heavy outlay, and probably heavy depreciation. There is no need for sub-stations; the low pressure network may be fed at various points by transformers and feeders coming direct from the station. These transformers need not be in houses or cellars; they can be placed conveniently in the ground in cases filled with insulating oil. At the station each feeder can be regulated, and has a compound wound voltmeter, so that an attendant can keep the pressure in the whole town constant. As Mr. Kapp pointed out in 1888, the advantage of such a system is enormous. In direct currents the low pressure mains must be large.

Even in scattered districts it would generally pay to use small low pressure mains and feeders. The alternate system has so many advantages over the direct in the matters of regulation and distribution when worked on the low pressure system, that it is astonishing that such arrangements are not utilized. For instance, with direct currents it is most difficult to find a leak; and one leak on the positive at the west end, combined with one leak on the negative at the east, will cause serious trouble. With alternate currents, a number of small local networks may be used, each of them being complete in itself. It is not in metallic connection with any other part of the town, nor with the central station. Where it meets the network of the neighboring district it is not metallically joined, as in the case of direct currents, but connected through a one-to-one transformer sunk in the ground, in a case full of oil.

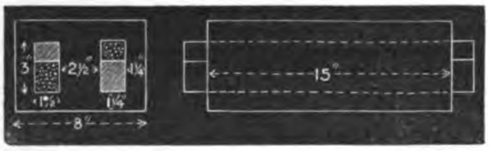


FIG. 11.

After the clear and able manner in which Mr. Kapp urged the advantages of low pressure networks for alternating currents, it is most astonishing that engineers should go on with house transformers. At present, however, we are using alternating currents in just about the worst way that could be possibly devised.

CONDENSERS.

Condensers may have a very large opening in connection with ordinary alternate-current distribution. Take the case of arc lamps. For instance, suppose a station supplies a 100-volt secondary circuit by means of transformers with 2,000 volts primary pressure; and suppose there are 200 arc lamps, each taking 33 volts and 10 amperes, arranged on the 100-volt circuit, with a choking coil in series with each. Suppose, for simplicity, that there are no incandescent lamps in use. The arc lamps then take 2,000 amperes and 100 volts; but this does not amount to more than 66,000 watts, as the current is not in step with the electromotive force. **The dynamos thus have to supply 2,000 volts and 100 amperes; whereas the same power, if the current did not lag, would be supplied by 2,000 volts and 33 amperes. This gives rise to several troubles. Suppose each machine has an armature wound to give 2,000 volts and 33 amperes, or 66,000 watts, it takes three instead of one to work the lamps. In addition to this, the lagging of the current weakens the field of the dynamos, so that they need more excitation to give 2,000 volts than they would need even on full load on a non-inductive resistance. Moreover, running three engines and dynamos at a third load instead of one at full load is not economical. A condenser takes a current which leads relatively to the pressure, so that it counteracts the effect of the lagging current. The 100 amperes may be regarded** as compounded of 33 amperes in step with the pressure, and 95 amperes lagging a quarter of a period. A condenser of about 85 microfarads will supply the 95 ampere component, while one dynamo supplies the 33 amperes really needed by the lamps. This reasoning holds good without the curve of sines assumption.

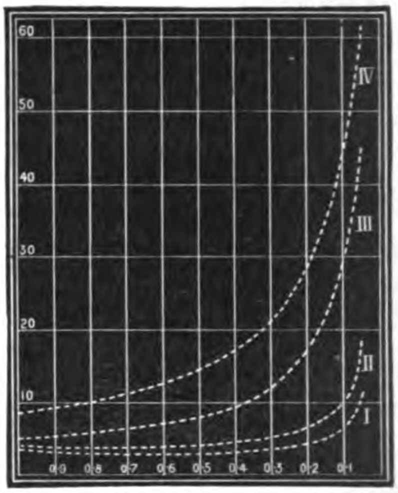


FIG. 12.

The use of condensers to overcome troubles arising from exciting or magnetizing currents of closed or open circuit transformers has already been mentioned.

The commercial manufacture of high pressure condensers is not easy, but it may now be said that it can be carried out.

Society and Club Notes.

BUFFALO ELECTRICAL SOCIETY.

At the meeting of the above Society on April 6, Mr. Madison Buell read a most able and interesting paper on "The Electrical Utilization of Water Power," of which we give an extended abstract elsewhere. At the close of his paper, Mr. Buell said:

"I thank you for the honor conferred in placing me in the chair of the vice-presidency of this society. In this connection it is a great pleasure to me to show you in what high estimation this society is held by the electrical papers of this country. We are all of us individually and collectively, more or less, indebted to them for the able and superior manner in which they spread out for our information all the great mass of electrical facts that are tumbling in so rapidly from all parts of the world. What has been said of "books" can be more fitly said of all of our electrical papers, "there is hardly anything more pleasant than speaking of them, and communicating to the public, the richness of thought that we have acquired" by their perusal. Mr. T. C. Martin of THE ELECTRICAL ENGINEER says:

"As regards the Buffalo Electrical Society, it has always been a matter of surprise to me that its work is so continuous and so good."

"Its success shows a very general interest in electrical progress and prosperity among those who might reasonably plead preoccupation and the pressure of daily duties." We must remember that the "productions of the press, fast as steam can make and carry them, go abroad through all the land, silent as snowflakes, but potent as thunder. It is an additional tongue of steam and lightning, by which man speaks." The individual members of this society as well as the society as a body, gain nine tenths of their electrical information from THE ELECTRICAL ENGINEER and its contemporaries, and through them the society is well and honorably known throughout the world. Investment in the electrical papers of the present day is a perpetual source of income. Benjamin Franklin truly said, "if a man empties his purse into his head, no man can take it away from him."

Letters to the Editor.

PHENOMENA OF CURRENTS OF HIGH FREQUENCY.

I cannot pass without comment the note of Prof. Thomson in your issue of April 1, although I dislike very much to engage in a prolonged controversy. I would gladly let Prof. Thomson have the last word, were it not that some of his statements render a reply from me necessary.

I did not mean to imply that, whatever work Prof. Thomson has done in alternating currents of very high frequency, he had done subsequent to his letter published in the *Electrician*. I thought it possible, and even probable, that he had made his experiments some time before, and my statement in regard to this was meant in this general way. It is more than probable that quite a number of experimenters have built such machines and observed effects similar to those described by Prof. Thomson. It is doubtful, however, whether, in the absence of any publication on this subject, the luminous phenomena described by me have been observed by others, the more so, as very few would be likely to go to the trouble I did, and I would myself not have done so had I not had beforehand the firm conviction, gained from the study of the works of the most advanced thinkers, that I would obtain the results sought for. Now, that I have indicated the direction, many will probably follow, and for this very purpose I have shown some of the results I have reached.

Prof. Thomson states decisively in regard to experiments with the incandescent lamp bulb and the filament mounted on a single wire, that he cannot agree with me at all that conduction through the glass has anything to do with the phenomenon observed. He mentions the well-known fact that an incandescent lamp acts as a Leyden jar and says that "if conduction through the glass were a possibility this action could not occur." I think I may confidently assert that very few electricians will share this view. For the possibility of the condenser effect taking place it is only necessary that the rate at which the charges can equalize through the glass by conduction should be somewhat below the rate at which they are stored.

Prof. Thomson seems to think that conduction through the glass is an impossibility. Has he then never measured insulation resistance, and has he then not measured it by means of a conduction current? Does he think that there *is* such a thing as a perfect non-conductor among the bodies we are able to perceive? Does he *not* think that as regards conductivity there can be question only of degree? If glass were a perfect non-conductor, how could we account for the leakage of a glass condenser when subjected to steady differences of potential?

While not directly connected with the present controversy, I would here point out that there exists a popular error in regard to the properties of dielectric bodies. Many electricians frequently confound the theoretical dielectric of Maxwell with the dielectric bodies in use. They do not stop to think that the only perfect dielectric is ether, and that all other bodies, the existence of which is known to us, must be conductors, judging from their physical properties.

My statement that conduction is concerned to some, although perhaps negligible, extent in the experiment above described was, however, made not only on account of the fact that all bodies conduct more or less, but principally on account of the heating of the glass during the experiment. Prof. Thomson seems to overlook the fact that the insulating power of glass diminishes enormously with the increase in temperature, so much so, that melted glass is comparatively an excellent conductor. I have, moreover, stated in my first reply to Prof. Thomson in your issue of March 18, that the same experiment can be performed by means of an unvarying difference of potential. In this case it must be assumed that some such process as conduction through the glass takes place, and all the more as it is possible to show by experiment, that with a sufficiently high steady difference of potential, enough current can be passed through the glass of a condenser with mercury coating to light up a Geissler tube joined in series with the condenser. When the potential is alternating, the condenser action comes in and conduction becomes insignificant, and the more so, the greater the rate of alternation or change per unit of time. Nevertheless, in my opinion, conduction must always exist, especially if the glass is hot, though it may be negligible with very high frequencies.

Prof. Thomson states, further, that from his point of view I have misunderstood his statement about the limit of audition. He says that 10,000 to 20,000 alternations correspond to 5,000 to 10,000 complete waves of sound. In my first reply to Prof. Thomson's remarks (in your issue of March 18,) I avoided pointing out directly that Prof. Thomson was mistaken, but now I see no way out of it. Prof. Thomson will pardon me if I call his attention to the fact he seems to disregard, namely, that 10,000 to 20,000 alternations of current in an arc—which was the subject under discussion—do not mean 5,000 to 10,000, but 10,000 to 20,000 *complete waves of sound.*

He says that I have adopted or suggested as the limit of audition 10,000 waves per second, but I have neither adopted nor suggested it. Prof. Thomson states that I have been working with 5,000 to 10,000 complete waves, while I have nowhere made any such statement. He says that this would be working below the limit of audition, and cites as an argument that at the Central High School, in Philadelphia, he has heard 20,000 waves per second; but he wholly overlooks a point on which I have dwelt at some length, namely, that the limit of audition of an arc is something entirely different from the limit of audition in general.

Prof. Thomson further states, in reply to some of my views expressed in regard to the constant current machines that five or six years ago it occurred to him to try the construction of a dynamo for constant current, in which "the armature coils were of a highly efficient type, that is, of comparatively short wire length for the voltage and moving in a dense magnetic field." Exteriorly to the coils and to the field he had placed in the circuit of each coil an impedance coil which consisted of an iron core wound with a considerable length of wire and connected directly in circuit with the armature coil. He thus obtained, he thought, "the property of considerable self-induction along with efficient current generation." Prof. Thomson says he expected "that possibly the effects would be very much the same as those obtainable from the regularly constructed apparatus." But he was disappointed, he adds. With all the consideration due to Prof. Thomson, I would say that, to expect a good result from such a combination, was rather sanguine. Earth is not farther from Heaven than this arrangement is from one, in which there would be a length of wire, sufficient to give the same self-induction, wound on the armature and utilized to produce useful E. M. F., instead of doing just the opposite, let alone the loss in the iron cores. But it is, of course, only fair to remember that this experiment was performed five or six years ago, when even the foremost electricians lacked the necessary information in these and other matters.

Prof. Thomson seems to think that self-induction wipes out the periodical undulations of current. Now self-induction does not produce any such effect, but, if anything, it renders the undulation more pronounced. This is self-evident. Let us insert a self-induction coil in a circuit traversed by an undulating current and see what happens. During the period of the greatest rate of change, when the current has a small value, the self-induction opposes more than during the time of the small rate of change when the current is at, or near, its maximum value. The consequence is, that with the same frequency the maximum value of the current becomes the greater, the greater the self-induction. As the sound in a telephone depends only on the maximum value, it is clear that self-induction is the very thing required in a telephone circuit. The larger the self-induction, the louder and clearer the speech, provided the same current is passed through the circuit. I have had ample opportunity to study this subject during my telephone experience of several years. As regard the fact that a self-induction coil in series with a telephone diminishes the loudness of the sound, Prof. Thomson seems to overlook the fact that this effect is wholly due to the impedance of the coil, *i. e.*, to its property of diminishing the *current strength.* But while the current strength is diminished the undulation is rendered only more pronounced. Obviously, when comparisons are made they must be made with the same current.

In an arc machine, such as that of Prof. Thomson's, the effect is different. There, one has to deal with a make and break. There are then two induced currents, one in the opposite, the other in the same direction with the main current. If the function of the mechanism be the same whether a self-induction coil be present or not, the undulations could not possibly be wiped out. But Prof. Thomson seems, likewise, to forget that the effect is wholly due to the defect of the commutator; namely, the induced current of the break, which is of the same direction with the main current and of great intensity, when large self-induction is present, simply bridges the adjacent commutator segments, or, if not entirely so, at least shortens the interval during which the circuit is open and thus reduces the undulation.

In regard to the improvement in the feeding of the lamps by vibrations or undulations, Prof. Thomson expresses a decisive opinion. He now says that the vibrations *must* improve the feeding of a clock-work lamp. He says that I "contented myself by simply saying," that I cannot agree with him on that point.

Now, *saying it*, is not the only thing I did. I have passed many a night watching a lamp feed, and I leave it to any skilled experimenter to investigate whether my statements are correct. My opinion is, that a clock-work lamp, that is, a lamp in which the descent of the carbon is regulated not by a clutch or friction mechanism, but by an escapement, cannot feed any more perfectly than tooth by tooth, which may be a movement of, say, $\frac{1}{32}$ of an inch or less. Such a lamp will feed in nearly the same manner whether the current be perfectly smooth or undulating, providing the conditions of the circuit are otherwise stable. If there is any advantage, I think it would be in the use of a smooth current, for, with an undulating current, the lamp is likely to miss some time and feed by more than one tooth. But in a lamp in which the descent of the carbon is regulated by friction mechanism, an indulating current of the proper number of undulations per second will always give a better result. Of course, to realize fully the benefits of the undulating current the release ought to be effected independently of the up-and-down movement I have pointed out before.

In regard to the physiological effects, Prof. Thomson says, that in such a comparatively poor conductive material as animal tissue the distribution of current cannot be governed by self-induction to any appreciable extent, but he does not consider the two-fold effect of the large cross-section, pointed out by Sir William Thomson. As the resistance of the body to such currents is low, we must assume either condenser action or induction of currents in the body.

NIKOLA TESLA.

NEW YORK, April 4, 1891.

Literature.

The Elements of Dynamic Electricity and Magnetism: By Philip Atkinson, A. M., Ph. D. New York: *D. Van Nostrand Co.*, 1891. 5x8 inches; 405 pages. Price, $2.

While there is no lack of books on the elements of electricity and magnetism, there has of late arisen a demand for a class of works which shall be adapted not only to the learner who desires to continue his studies with special reference to their future application in actual work, but also for that large class which has come to take a lively interest in electrical work, because it has been so forcibly brought to public attention during the last few years. A book to interest these learners and general readers, therefore, must present the subjects in their plainest dress, and must convey the facts through the medium of conclusive inductive reasoning rather than by the aid of formulæ. It is from this standpoint that the author has treated the subject matter contained in the book, which forms a companion work to that previously published, entitled "Elements of Static Electricity." In the present work the author has taken up the subject of dynamo electricity and magnetism, and very properly begins with definitions and a description of the voltaic battery. He describes the principal single and double fluid cells now in common use, and their method of operation. Two chapters on magnetism and electro-magnetism discuss the wide range of these phenomena. The author leads up from the natural magnet to the mariner's and surveyor's compass and gives one of the most complete short exposés of terrestrial magnetism that has come under our observation. He also discusses the form of magnets, and their polar attraction and repulsion. Passing on to electro-magnetism, we find a treatment of the laws governing the relation between currents carried in neighboring conductors and the effects of currents upon magnets and upon masses of iron. The author explains very clearly the simple rules by which all these phenomena may be remembered, and shows their application to the construction of the Ruhmkorff coil, which is described very fully.

Chapter VI is devoted to electric measurement. In it are described the various electrical units employed in practical electrical work, and this is followed by a description of the most generally employed testing instruments, among them the Thomson galvanometer, the Weston voltmeter, the Wirt voltmeter, the Cardew and others. The dynamo and motor are then taken up, and after a few short introductory paragraphs on the history of the dynamo, the author at once brings us to the types employed at the present time and their construction. This survey includes not only those of the well-known continuous current machines, but also the best known alternating current dynamos and motors. Thermo-magnetic motors are also touched upon here. Electrolysis and electric storage form the subject matter of the two following chapters, introduced by the theory of Grotthuss, which still seems to be the favorite one for text book purposes, and perhaps justly so. The application of the laws of electrolysis to electric storage is also pointed out, and the construction of the most recent types of secondary batteries is described and illustrated. The relations of electricity to heat form a chapter which will attract considerable interest as we find in it, besides the laws governing the generation of heat in conductors, a simple statement of electro-thermic phenomena and a description of the latest forms of the Thomson welding machine, and the results which have been obtained with it. The relation of electricity to light forms the subject matter of Chapter XI, in which the various phenomena of the effects of light on selenium are described, together with the magneto-optic polarization effects, and the various other photo-electric phenomena discovered by Becquerel, Kerr and others. The author then takes up the arc light and discusses its nature, and the most general types of lamps employed. This is followed by similar treatment of the incandescent lamp, in which connection the two and three wire systems of distribution are described. The telegraph and the telephone, to each of which a chapter is devoted, end the volume.

While we are not prepared to agree entirely with all the views expressed by the author, especially on points of theory, the present unsettled state of the latter might be easily made to account for divergences. If we may also be allowed to suggest, we think that the work in further editions, which will undoubtedly be called for, might be improved by a more rigid adherence to the classification of the subjects treated. The book has the undoubted merit of giving the latest information on the practical advances made, and does not burden the reader with a long and profitless review of what has been done during the last fifty years. The book is admirably printed and illustrated, and the author has evidently availed himself of the latest and best sources of information. We trust that the publishers will find their enterprise fully rewarded.

THE SWINBURNE TRANSFORMERS.

In my letter appearing in your last issue an error was made in the statement beginning; "In the communication from Mr. Swinburne a few days after the publishing of my article, Mr. Swinburne, etc." It should read as follows: "In a communication received from Messrs. Swinburne & Co. a few days after the publishing of my article, etc., they state that the leakage current in their transformers of 40 lights capacity is about 40 per cent.: allowing that this 40 per cent. is correct, the comparative leakage current in the open and closed types of transformers is approximately 10 to 1."

WM. STANLEY, JR.

PITTSFIELD, MASS.

WHAT ARE THE LIMITS OF HIGH POTENTIAL TRANSMISSION?

IN another column we describe the tests which have recently been made to demonstrate the possibility of transmitting electrical energy between Lauffen and Frankfort, in which potentials of over 30,000 volts were employed. These experiments appeared to indicate the practical success of the system, but in a letter appearing in the *Elektrotechnische Zeitschrift*, August Schneller, of The Hague, Holland, draws attention to certain points, which, he claims, have not been fully considered. He writes as follows:

"In our technical papers, the power transmission project from Lauffen to Frankfort, on the occasion of the Frankfort Exhibition, has been the frequent object of discussion of late. Although in the carrying out of my experiments in the preparation of ozone, I have already had considerable experience with alternating currents up to 24,000 volts potential, I have up to now avoided taking part in this discussion. Since, however, this project has been seriously taken up and spoken of by his Excellency, Dr. Von Stephan, I have regarded it as my duty to testify to the enormous difficulties of transmitting power with 20,000 volts alternating current, which make its carrying out in practice impossible. The transmitted 300 h. p. may have at the primary transformer 30,000 volts and 6.2 amperes=186,000 watts. To obtain 30,000 volts by transformation in commercially practicable apparatus, so as to be safe, is indeed difficult, but under certain construction not impossible.

"The chief difficulty in the transmission of 30,000 volts lies not, however, in the fourfold transformation and the loss thereby entailed, nor in the transformers themselves, but in the outside conductors. With 6.2 amperes, with a copper wire of 5 mm. diameter, and with 350 kilometres of wire the drop in potential amounts to only 1,830 volts = 6.1 per cent.; but the other losses which the conductors are subject to have been entirely left out of account up to the present. For the overhead conductors telegraph poles are necessary, which ought not to be more than 50 metres apart, so that altogether there will be 3,500 telegraph poles, and 7,000 oil insulators. One insulator, even an oil insulator, has an average resistance of 1,000 megohms when measured with low potential battery current. For 7,000 insulators there may then be a resistance of 150,000 ohms; then there would be, at 30,000 volts, 0.2 ampere loss, which loss of 3.2 per cent., in such an important undertaking, may almost be neglected.

"Now, however, comes the principal point: The 'charging loss,' according to my measurements, for an air dry insulator at 15,000 volts, amount to 2.3 watts; at 20,000 volts to 4.7 watts, and at 30,000 volts might reach about 15 watts. In the 7,000 insulators then, in dry weather, there would be about 100,000 watts loss. The losses in foggy or rainy weather are still left quite out of the calculation. If we assume a distance between the parallel conductors of one metre, there results, at 30,000 volts potential, a loss of 0.15 watt per metre by silent discharge; hence, for 175 kilometres, a loss of 26,000 watts. Allowing an efficiency of 95 per cent. for the primary and secondary machines and 98 per cent. for the transformers at full load, the loss in the line 6.1 per cent., the insulation loss 3.2 per cent., the 'charging loss' on the insulators at 100,000 watts, and the silent discharge in 175 kilometres of parallel conductors at 26,000 watts, then we come to the conclusion that in dry weather, from the Lauffen plant of 300 h. p. we will get in Frankfort about 37 h. p.

"There must be taken into account still further, about 6,000 square metres of condensing surface of the conductors and insulators. I have measured the sparking distance with 20,000 volts alternating current at 100 reversals per second, without any condenser, and found it to be 46 mm.; and when a condenser of 15 sq. mm. surface was included, the sparking distance was more than 80 mm.; but how great the sparking distance is with 6,000 square metres of condensing surface, goes beyond my experience. On the basis of these truths it is easily seen that the whole project is a technical impossibility."

Reports of Companies.

ANNUAL MEETING OF THE AMERICAN BELL TELEPHONE CO.

The annual meeting of the American Bell Telephone Co. was held in Boston, on March 31. Mr. J. E. Hudson, the president, read the annual report, which stated the increase in the number of stations during the year as 17,928. The estimated number of exchange connections daily in the United States is 1,438,294, a total per year of 450,000,000. The average cost to the subscriber varied, according to the size of the exchange and character of the service, from less than 2 to 14 cents per connection.

There was an increase of 28,147 underground wires during 1890, and and an increase of 38,929 instruments under rental, the total number being 483,790.

The miles of wire at the 1st of January, 1891, 240,412, against 193,213 on the 1st of January, 1890, shows an increase in that direction of 47,199 miles. Of this, something over one-half, 27,578, is a gain in mileage of wire underground—a gain that exceeds the total mileage of underground wire existing at the beginning of the year. This marks the rapid development and occupation of the underground systems, largely in New York, Chicago and Boston.

The New England Company's new switch-board has been set up. The switch-board will be in operation about the first of May, and the direct connections from the new office to subscribers' stations, through the extensive underground system of conduits and cables radiating from the Telephone building, will be completed within three or four months thereafter. With its enlarged capacity and improved equipments, the exchange will thus be in a condition to meet the requirements of its rapidly growing business.

The report was accepted and placed on file.

The treasurer's report was as follows :

DEBTORS.

Telephones	$919,274.94
Real estate	744,333.00
Stocks	32,740,580.03
Merchandise and machinery	9,932.94
Bills and accounts receivable	2,034,280.02
Cash and deposits	187,935.39
Total	$36,636,336.32

CREDITORS.

Capital stock	$12,500,000.00
Debenture bonds, 1888	2,000,000 00
Bills and accounts payable*	1,334,636.14
Patent account (profit and loss)	10,516,544.96
Profit and loss	5,645,131.11
Reserve	2,489,012.50
Surplus	2,151,011.61
Total	$36,636,336.32

*Of this amount $375,000 is the dividend payable Jan. 15, 1891, to stockholders of record Dec. 31, 1890.

EARNINGS.

	1889.	1890.
Rental of telephones	$2,657,361.90	$2,913,368.63
Dividends	1,230,500.53	1,256,274.19
Extra territorial and branch lines	82.556.63	89,478.13
Telegraph commission	22,367.02	26,491.60
Interest	43,964.44	77,447.89
Miscellaneous	7,954.19	12,230.44
	$4,044,704.71	$4,375,290.88

EXPENSES.

Expenses of operation	$269,493.37	$311,437.98
Legal expenses	144,566.62	123,859.08
Interest and taxes	225,199.97	257,174.85
Commission	511,215.31	575.221.03
Royalty	10.500.00	10.000.00
Concessions	221.288.11	228,573.94
Miscellaneous	3.702.64	105.65
	$1,385,966.02	$1,505,872.53
Net earnings	$2,658,738.69	$2,869,418.35
Miscellaneous items to surplus account	3,150.00	
Totals	$2,661,888.69	$2,869,418.35
Surplus account, Dec. 31, 1889	$2,151,011 61	
Net earnings, 1890	2,869,418.35	
		$5,020,429.90
Regular dividends in 1890	$1,463,913 00	
Extra dividends in 1890	750,000.00	
Reserve for general depreciation	600,000.00	
Reserve for depreciation of instruments	55,505.35	
		2,869,418 35
Surplus account, Dec. 31, 1890		$2,151,011.61

The election of a board of directors for the ensuing year then took place, and resulted as follows :—Thomas B. Bailey, Francis Blake, Charles P. Bowditch, George L. Bradley, Alexander Cochrane, William H. Forbes, Henry S. Howe, Charles Eustis Hubbard, Gardiner G. Hubbard, John E. Hudson, Charles E. Perkins, Thomas Sanders.

The board of last year was re-elected, with the exception of the substitution of the name of Thomas B. Bailey for that of Stanton Blake, who is ill.

ANNUAL MEETING OF THE BURTON ELECTRIC COMPANY.

The annual meeting of the stockholders of the Burton Electric Company was held in Richmond, Va., on the 25th of March, when W. R. Mason, of the Electric Merchandise Company, of Chicago, was elected president ; W. J. Johnson, president Citizens' Bank, Richmond, vice-president ; C. E. Wings, treasurer ; A. Pizzini, secretary, and W. Leigh Burton, superintendent.

Reports of officers show the company to be in a prosperous condition. President Mason is looked upon as a most valuable acquisition to the Burton Company.

ELECTIONS.

Bristol, Pa.—At the annual meeting of the Bristol Electric Light and Power Company, a dividend of five per cent. on the capital stock was declared and the following directors were chosen: George A. Shoemaker, A. Weir Gilkeson, Frank F. Bell, Leopold Landreth and W. H. H. White. President, George A. Shoemaker ; secretary, A. Weir Gilkeson ; treasurer, Charles E. Scott.

Goshen, Ind.—At a meeting of the stockholders of the Citizens' Electric Company the following directors were elected : O. M. Curtis, A. E. Brownell, Albert Yates, Harris Dembufsky and M. E. Meader. The new board will organize and assume management of the plant on the first Tuesday in April.

Ware, Mass.—The Ware Electric Company has elected these officers : President, Frank M. Sibley ; vice-president, Andrew Bryson ; secretary, William C. Eaton.

STOCKS AND BONDS.

Belleville, Ill.—Judge Benjamin Boneau has appointed Mr. M. W. Weir, to be assignee of the Electric Date and Stamp Company, of East St. Louis, vice George B. Dodge, deceased.

New Bedford, Mass.—At a recent meeting of the stockholders of the Union Street Railroad Company, it was unanimously voted to authorize the directors to petition for leave to increase the capital stock of the corporation from $260,000 to $500,000. It is understood that the increased stock will be largely used in the equipment of the road with electric apparatus, and that the Fairhaven division will be the first to have the system applied.

Lancaster, N. H.—At a recent meeting of the Lancaster Electric Company, it was voted to increase the capital stock to $18,000.

DIVIDENDS.

Boston, Mass.—The New England Telegraph and Telephone Co. has declared a dividend of 75 cents a share.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of April 4, 1891, from New York, Boston and Washington ; Pittsburgh, April 3.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80¼	Edison Gen. Elec. Co	100
American Tele. & Cable	88	Consol'd Elec. Lt. Co	...
Centl. & So. Amer	*145	Edison Illn'g Co. N. Y	79
Mexican	210	U. S. Elec. Lt. Co	....
Com. Cable Co	104¼	North Am. Phonograph	....
Postal Tel. Cable	89		

BOSTON.

	BID.		BID.
Thomson-Houston	44¼	Ft. Wayne Co	12¼
" Pref'd	25	Am. Bell	197
" Series C	9¼	Erie	49¼
" " D	7	New England	50
" Int. Co	....	Mexican	.90 cts.
Thomson Welding Co	....	Trop. American	.80 cts.
Thomson Eu. Welding	...	Edison Phon'gph Doll	....
Westinghouse El. Man. Co.	11¼		

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	167
Ches. & Pot. Telephone	58¼	Eck.&Sold. Home Elec. Ry.	56⅜
Amer. Graphophone	6	Georgetown & Tenallytown	60

Legal Notes.

THE STATUS AND CLAIMS OF THE ADAMS ELECTRIC COMPANY.

In a recent issue we made note of the fact that the Adams Electric Co., of St. Louis, proposed to institute suit for infringement against the various companies now building electric railway apparatus. In view of these contemplated proceedings, a brief account of the facts upon which the claims for infringement are based will prove of great interest to our readers.

In a "statement," just issued by Prof. Francis E. Nipher, president of the company, we learn that the Adams Electric Railway Company, has for the basis of its organization, two patents granted to Wellington Adams, June 24, 1884. Some time prior to 1878, the patentee, Dr. Wellington Adams, while practicing medicine in Washington, D. C., conceived the idea of propelling cars by power electrically transmitted to them while in motion. His studies and experiments assumed a somewhat practical shape in the winter of 1878, when, in a course of lectures delivered in Colorado Springs, he exhibited a working model representing an electric railway system embodying this idea Being soon called to a chair in the Medical College at Denver, he there continued to pursue his investigations in this line until finally he became so much impressed with the importance and value of his invention, that he gave up his professorship and came East in order to find better facilities for developing his ideas. In 1881 he made application for a patent embodying this broad idea of propelling cars by electricity, generated at a stationary point and transmitted to them while in motion. This was, however, refused him, on the ground that the fundamental conception of the system had already been proposed and provisionally patented in England, by one, Henry Pinkus, although no publicity had been given to the matter, since the details involved in the Pinkus system were absolutely impracticable. Dr. Adams then began work on the practical details, with a view of solving the mechanical and electrical problems involved, and thus discovering and supplying the best and simplest mechanism and the most effective electrical motor. Making his headquarters at Chicago, he there devoted his entire time, as well as that of several assistants and engineers, to the carrying out of his plan, when the failure of his funds caused him to suspend operations and return to the practice of his profession, devoting only his spare time and means to the study of the great problem.

In the early part of 1883 he was invited to go to St. Louis to explain his plans to a few capitalists, who became interested in the matter and organized a company to enable him to make practical experiments on the most desirable motors and the best means of applying their power. This latter feature was the great problem which he set himself to solve. He everywhere, and always by word of mouth and by pen, contended that the solution of this one problem of the proper method of mechanically transmitting the power of the motor to the driven car, would prove the *sine qua non* of success—the key to the situation. His ideas as to the proper solution of this particular problem were embodied in two U. S. patents, numbered respectively 300,827 and 300,828, which were granted him on June 24, 1884.

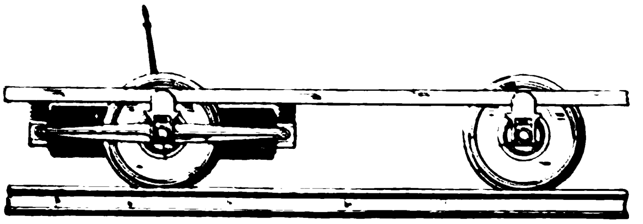


FIG. 1 OF THE ADAMS PATENT]

The accompanying engravings are reproduced from Figs. 1 and 3 of the latter patent, the claims of which are as follows:

1. The combination, with the axle which carries the driven wheels, the axle boxes or bearings, and a frame secured to or formed in one with said boxes or bearings, of an electric motor whose armature is mounted to revolve on said axle, and whose field is attached to and carried by said frame, substantially as and for the purposes hereinbefore set forth.

2. The combination with the driven wheels, their axle and axle boxes or bearings, and a field supporting frame secured to or formed in one with said boxes or bearings, of an electric motor whose armature and field are carried by said axle and frame, respectively, and intermediate power-transmitting gearing, also carried by said frame, and meshing on the one hand with a gear on the driven wheels and on the other with a gear on the armature hub.

3. The driven wheels, their axle and axle boxes or bearings and the supporting-frame secured to or formed in one with said boxes or bearings, in combination with the armature mounted to revolve on said axle, and the field-magnets, commutator-brushes, and intermediate power-transmitting gearing mounted in and carried by said supporting-frame, under the arrangement and for operation as hereinbefore set forth.

Soon after the patents were granted, efforts were made to secure contracts for the equipment of various street railroads. But the street railroad companies could not then be convinced of the practicability of the project. The inventor then concluded that the only way out of the difficulty would be to construct a road of his own, the primary object of which should be to utilize his own inventions and thus prove their practical value. This proposed road, embodying his inventions, was exhibited at the first St. Louis Exposition, in 1884, and the following year he succeeded in securing from the Municipal Assembly a franchise for an elevated electric railway, thus standing on the threshold of success as the builder of the first extensive electric railroad system in the world. But he was doomed to disappointment, for the mayor of St. Louis vetoed the Adams Elevated Electric Railway bill. This reverse brought panic and discouragement to the gentlemen composing the company, who felt that they had spent enough money on electric railways, and in efforts to demonstrate the practical value of their patents. An elaborate and very interesting paper embodying his ideas, was printed by Dr. Adams in the *Journal of the Association of Engineering Societies* in 1884, and was republished by him in pamphlet form in 1886. It was read before the Engineers' Club, of St. Louis, April 23, 1884.

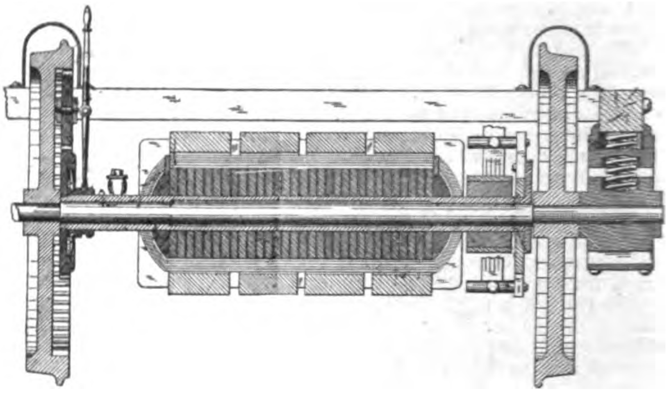


FIG. 3 OF THE ADAMS PATENT.

The company claims that all railway cars now operating electrically embody the features of the Adams patents in the machinery which propels them, and it is these features which has made the present success possible. Furthermore, that the improvements that are now being made and which are promised in the future, simply consist in copying more faithfully the specific device in which Dr. Adams embodied his invention.

The officers of the company are: Francis E. Nipher, president; Ewing Hill, secretary and treasurer, and Wellington Adams, general manager.

IMPORTANT ELECTRICAL UTILIZATION OF WATER-POWER AT JOPLIN, MO.

Note has been made from time to time of the important work that has lately been undertaken near Joplin, by the Southwestern Electric Light and Water Power Co. We are now in receipt of an interesting letter on this subject from Mr. Charles E. Hart, superintendent of the company, who says:—"Our plant consists of a very fine natural water power about five and a half miles from this city, which, when we complete our present installation will be some 2,000 effective horse power. We have a very fine concrete dam and our turbines are James Leffel & Co. 66 inch wheels, which we work under a head of 21 feet. We transmit our power into our generating station by a large leather belt 65 feet between driving centres. All the pulleys on our main shaft are fitted with Eclipse friction clutches, thus giving us good control of all our apparatus. Our electrical equipment consists of one 1,500 light 2,000 volt alternating dynamo, and two 50 light 2,000 c. p. arc machines. We are using the light from these machines at Joplin, from five and a half to six miles away from the station.

"Our power transmission will extend for from two and a half to four miles, and for this coming summer will consist of about 300 h. p., which will be divided into units of from 5 to 30 h. p. motors, which we shall put out at an average rental of three cents per horse-power hour. We have a very fine pole line of 35 foot poles, with eight inch tops, set six feet deep, and the entire line is painted and well guyed. We are engaged in working out a problem here. While great advance has been made upon it already, we still know of no place that is transmitting as large an amount of horse-power as long a distance as we will be doing in the near future. I might state that all our electrical equipment is Thomson-Houston make."

MR. BERT POWELL has obtained the important position of superintendent of the Electric Light and Power Co., of Eau Claire, Wis.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 31, 1891.

Alarms and Signals :—

Electric Alarm for Shaft Bearing, G. Hanna, 449,411. Filed Dec. 24, 1890.
Electro-magnetic apparatus adapted to notify of any derangement or wearing in the out-board bracket supporting the shafts of twin-screw steamships.

Repeater, F. W. Cole, 449,574. Filed May 12, 1890.
A repeater for alarm or signal circuits, as in police service, for the automatic transmission over any number of circuits of signals received at a central station over one circuit.

Non-Interference Signal Box, F. W. Cole, 449,575. Filed June 9, 1890.
Relates to the locking and actuating mechanism of boxes employing a signaling train.

Non-Interference Signal Box, F. W. Cole, 449,576. Filed Oct. 20, 1890.
Relates to the construction and operation of locking, and releasing mechanism.

Conductors, Conduits and Insulators :—

Art of Covering Electric Wires, T. W. Norman, 449,163. Filed April 29, 1890.
Relates to a method of covering insulated wires or cables with lead or other metal. The metal is applied in the form of a flat strip, or ribbon, having scarfed edges to secure a smooth overlap ; the edges are then soldered and the covering compressed.

Insulated Electric Conductor, J. D. Bishop, 449,400. Filed Sept. 22, 1890.
The conducting core is wound with a paper ribbon the spiral edges of which are separated by a spiral air space and enclosed within a protective sheath.

Distribution :—

Regulating Apparatus for Electric Currents, W. Lahmeyer, 449,288. Filed Feb. 9, 1888.
For regulating automatically from a central station, without any special circuit, the current received by lamps connected at the ends of a lighting circuit. Consists of a cistern of mercury, floats, and multiple contacts, with a series of relays arranged on high resistance shunts, successively thrown into action by varying strength of current in the main lead.

Dynamos and Motors :—

Dynamo Regulator, B. H. Fisher, 419,245. Filed Sept. 15, 1890.
The motion for adjusting the brushes is derived from that of one of the field-magnets. An additional field-magnet is provided and is so mounted as to be capable of movement under changes in the "neutral line" and of communicating motion to the brushes.

Electric Contact, O. J. Depp, 449,348. Filed Jan. 24, 1891.
Adapted for commutator brushes and arranged to prevent the flow of current through the pressure springs.

Galvanic and Thermo-Electric Batteries :

Thermo-Electric Batteries, J. N. Webb, 449,186. Filed July 19, 1890.
A portable battery. The end parts, for heating or cooling, are of large size relatively to the connecting strips, which latter may be flexible.

Galvanic Battery, H. P. Stoecker, 449,299. Filed Dec. 4, 1890.
Relates to the method of attaching connecting wires, and to a cathode formed of a series of carbon rods arranged in contact with each other.

Lamps and Appurtenances :—

Hanger for Electric Lamps, H. A. Foster, 449,153. Filed August 1, 1890.
For suspending arc lamps from the side walls of buildings or other similar positions.

Electric Arc Lamp, J. H. R. Ward, 449,236. Filed Dec. 8, 1890.
Relates to the globe-holder and is designed to facilitate the removal and replacing of the globe.

Electric Arc Lamp, J. H. R. Ward, 449,237. Filed Dec. 8, 1890.
Relates to the mechanical details of arc lamps of the type adapted for low electromotive force.

Electric Arc Lamp, J. H. R. Ward, 449.238. Filed Dec. 11, 1890.
Relates particularly to means for improving the uniformity of the arc, especially during the period immediately following the turning on of the circuit.

Hanger Board for Electric Fixtures, G. R. Lean, 449,266. Filed June 9, 1890.
Especially adapted for use where lamp fixtures must be made very short.

Incandescent Electric Lamp Socket, F. A. Weller, 449,604. Filed Aug. 11, 1890.
Intended to facilitate connecting, disconnecting or adjusting the circuit wires.

Medical and Surgical :—

Electric Belt, D. P. Andrus, 449,345. Filed Nov. 7, 1890.

Electro-Therapeutic Syringe, E. Bartsch, 449,651. Filed June 28, 1890.

Metallurgical :—

Magnetic Separator, R. R. Moffatt, 449,610. Filed Aug. 25, 1890.
Has two rotating drums with an electro-magnet or magnets located outside of the drums and having a stationary pole-piece within each drum ; the pole-piece is magnetically connected with the magnet core through the axis of the drums.

Metal Working :

Method of and Apparatus for Electric Soldering, A. Robinson, 449,258. Filed Apr. 18, 1890.

Consists in passing a current through the solder to be applied, between two metallic conductors, which conductors with their adhering solder are applied to the metal of the joint, thus heating the metal by the combined effect of the melted solder and of some portion of the electric current.

Manufacturing Chains by Electric Welding Processes, E. Thomson, 449,356. Filed Apr. 28, 1890.
The abutting ends of chain links are welded by electric current : the electric heat is applied not only at the joint but also at the continuous part of the link opposite the joint ; the link is then subjected to pressure in a line transverse to that connecting the joint and the opposite heated portion. This method may be applied to produce chains having a protuberance or enlargement on the side of the links.

Burr Preventer for Electric Welding Machines, E. Thomson, 449,857. Filed Aug. 15, 1890.
The upset or enlarged portions usually produced adjacent to the ends or edges of the pieces of metal when joined are avoided by the employment of compressing rockers, or segments, pivoted so as to swing across the joint during the operation of welding.

Miscellaneous :—

Electric Switch, W. White, 449,188. Filed Dec. 3, 1889.
Intended to make a very rapid and complete break of contact.

Electro-Magnetic Device, M. G. Crane, 449,206. Filed July 16, 1888.
Shown as applied to an electric gong. The mechanical features are intended to provide for the development of a more than usually powerful blow from the hammer.

Electric Fuse, G. F. Curtiss, 449,209. Filed June 20, 1890.
The fuse wire is provided with an enclosing tube having a bore of such diameter that the wire fills the tube with very slight clearance, for the purpose of causing the sudden expulsion of the wire when melted.

Electric Switch, H. T. Clark, 449,282. Filed Feb. 25, 1891.
A compression and sliding contact.

Fuse for Electric Circuits, F. W. Maxstadt, 449.280. Filed Jan. 10, 1891.
Details of construction relating chiefly to the holder.

Cut-Out, C. S. Van Nuis, 449,301. Filed Aug. 18, 1890.
A "snap" switch designed especially for heavy currents and for compactness.

Electric Contact Protector, R. Varley, Jr., 499,202. Filed Nov. 28, 1890.
For the protection of contact points in electrical apparatus. It consists of two discs of flexible material connected together around their edges and having central openings for the electrodes,

Binding Post for Electric Wires, H. P. Ball, 419,307. Filed Dec. 16, 1890.
Adapted for wires of different sizes ; holds the wire by wedge action.

Electro-Magnet, F. A. Wessel, 449,358. Filed Nov. 19, 1890.
Relates to a method of winding electro-magnets and to permit the easy division of the wire into sections, each consisting of a single layer of wire. Applicable to field-magnets of dynamos.

Electric Switch-Box, J. H. Dean, 449,362. Filed Nov. 4, 1890.
A rheostatic-switch for use in connection with electric motors.

Electric Heating Apparatus, M. W. Dewey, 449,404. Filed Apr. 28, 1890.
For heating apartments by Electricity. It is a combination of an exposed electric heater and a ventilating fan mounted upon the same support or frame, the fan serving to distribute the heat.

System of Operating Electric Elevators, W. Baxter, Jr., 449,611. Filed Mar. 17, 1888.
A system of operating elevators by electric motors worked out with great elaboration and comprising devices and apparatus for securing control of the motive power and preventing mishaps under a variety of circumstances.

Railways and Appliances :—

Electric Railway Conduit, F. O. Blackwell, 449,196. Filed Mar. 5, 1889.
Consists of devices for supporting the insulated supply conductor. A common fastening device secures a clamp to a support in the upper part of the conduit and at the same time secures the conductor to the clamp.

Electric Motor Truck, F. O. Blackwell, 449,197. Filed Aug. 31, 1889.
The motor has two bearings upon the driven axle, to which it is geared, and has a single bearing upon the opposite axle supporting the free end of the motor.

Guard for Electric Railway Trolleys, A. W. Mitchell, 449,226. Filed June 23, 1890.
Has two arms, each having a flange extending over the wheel and provided with a slit or opening in line with and for the rim or edge of the wheel to project through.

Electrical Railway System, S. F. B. Morse, 449,227. Filed Oct. 29, 1890.
Combines an overhead trolley conductor and an insulated or underground conductor, both divided into corresponding and independent sections, switch levers or other devices at the junctions of the sections for connecting a conductor of one section with a conductor of another ; so that a section of one circuit may be substituted for its corresponding section in the other ; the switch levers are operated by electro-magnets ; supplemental circuits co-extensive with and corresponding to the sections on the main conductor are provided and include the electro-magnetic switching devices ; the supplemental circuit is adapted to be controlled by the movement of the cars.

Electric Lighting System, G. Gibbs, 419,474. Filed Aug. 14, 1890.
Relates particularly to the lighting of railway trains and to the direct supply of current by a dynamo. Includes the provision of a storage battery and an automatic switch mechanism by which the battery is held normally in circuit with leads ; an auxiliary circuit containing lamps and connected with the storage battery. On the cessation of current through the main circuit the auxiliary circuit is completed through the storage battery.

Guard for Electric Railway Trolleys, A. W. Mitchell, 449,490. Filed Dec. 1, 1890.
Has two arms, a cross-bar connecting the arms together, each arm having a curved slot and a flange extending over the trolley wheels, each arm at its side has a pin engaging with the curved slot, and a slot engaging with the journal pin of the trolley wheel ; a lever pivoted to the trolley rod engages with the cross bar of the flange and arms.

Automatic Trolley Catcher for Electric Railways, B. J. Parsons, 449,569. Filed Aug. 27, 1890.
To catch the trolley when it slips from the conductor and to draw it down to a suitable distance. Consists of a spring actuated winding cylinder or drum and holding or releasing mechanism.

Electric Railway Signal, S. Tompkins, 419,689. Filed Dec. 9, 1889.
For signals to and from moving trains generally, and particularly to the case of signaling to engineers upon their engines the proximity of other engines upon the same track. Employs a series of aligned conductor sections similarly connected ; the arrangement is such that each section exists between sections belonging to a group or groups other than its own ; groups in one series are connected with respective groups of the other series.

Telegraphs :—

Telegraph-Transmitter, H. G. Robbins, 449,174. Filed Nov. 29, 1890.
A key-board transmitter for Morse signals.

Telephones and Apparatus :—

Telephone Sound Transmitter, A. D. Schatz, 449,180. Filed Mar. 1, 1888.
A horn shaped sound conveyor for attachment to transmitting telephones, provided with an opening in its convex side near the large end. The speaker uses the opening in the side of the horn.

Telephone, W. Humans, 419,254. Filed July 23. 1885.
A magneto telephone. Consists of a permanent magnet whose elements are connected pole to pole to form a case, a diaphragm extending across the open end of the magnetic case thus formed, one or more pole pieces and coils within the magnetic case.

Patent Notes.

THE SLATTERY-STANLEY INTERFERENCE.—PARALLEL DISTRIBUTION BY ALTERNATING CURRENTS—COMMISSIONER'S DECISION FOR STANLEY.

The decision of the commissioner of patents in the interference case of Stanley v. Slattery, made February 24 and noticed in THE ELECTRICAL ENGINEER of March 4, is printed in the *Patent Office Gazette* of March 24. The case was on appeal from the Examiners-in-Chief who had awarded priority to Stanley. Stanley's application was filed August 15, 1888, at which time Slattery's patent had been issued, dated July 31, 1888. The commissioner, after an analysis of the case, confirmed the decision of the Examiners-in-Chief.

In view of the relative dates of Slattery's patent and Stanley's application the burden of proof was upon Stanley. In determining whether he had discharged that burden the commissioner first inquired into the proper construction of the points at issue. He found the limitation, qualification, or feature relied upon to impart novelty, in the following language from the first issue:

> Each converter made with a primary coil containing such length of wire exposed to magneto-electric induction that when operated by the dynamo with which it is to be used, with its secondary circuit open the electrical pressure and counter-pressure in its primary circuit shall be equal.

Similar language of limitation was found in each of the five issues in controversy, all of which were combinations, and in the 5th issue it was required that each converter shall contain

> A soft iron core weighing two pounds for each ampere of current normally produced in its secondary circuit.

The commissioner disregarded other and minor features of difference in the several issues.

"It is clear," he said, "that the feature or limitation of having the counter electromotive force or counter pressure produced in the primary coil of the converter equal to the applied electromotive force when the secondary circuit is open is essential to the issues, and it is equally clear that the primary coil of the converter must contain such length of wire exposed to electro magnetic induction as will bring about this equality of pressure and counter-pressure. I do not understand, however, that this equality of pressure and counter-pressure need be equal in an absolute sense."

Slattery's specification says:

> In this condition the ammeter will show no current whatever in the circuit of the primary when the secondary circuit is open.

Stanley, however, only requires proximate equality, and says:

> When so constructed an ammeter will practically show no current when the secondary circuit is open.

The commissioner, therefore, conceived the several issues to be satisfied by the substantial equality of applied and counter electromotive force when the secondary circuit is open.

Stanley's principal evidence related to a plant erected at Great Barrington, Mass., in March, 1886, in which he had seven converters arranged in multiple arc and supplying over 100 lamps, and having a capacity of 200 16 candle-power lamps. This plant was first started on March 16, 1886, and continued in successful operation until June 17 of the same year. It embodied the issues of this interference.

Stanley had produced as an exhibit in the case an old specification, dated November 26, 1885, which was never filed in the Patent Office, and which in its suggested claim distinctly called for

> A counter E. M. F. opposing the E. M. F. applied to their primary circuit of sufficient value to practically obstruct the flow of current between the mains when their secondary circuits are open.

And it also exhibited a rough drawing corresponding with the drawing of the application in interference. This paper, the commissioner said, made it difficult to avoid the inference that Stanley contemplated making the counter electromotive force practically equal to the applied electromotive force when the secondary circuit should be open, and that he also perceived and recognized the relation to the accomplishment of that result of the number of turns and lengths of wire in the primary coil. A paragraph of the claim of this old specification also set forth the fact that the core of the converter must be of magnetic resistance low enough to allow an equal or proportionate magnetic absorption throughout its working limits. Stanley had testified that the invention described in this unfiled specification, Exhibit 1, was embodied in an apparatus worked and tested at Pittsburgh, in September, 1885, and that the apparatus designed and used in Pittsburgh was a complete embodiment of the invention described and claimed in his application in interference; and that he considered at the time he had made an invention of value and importance. The proofs had shown that the Great Barrington plant was set up in March, 1886. It was distinctly stated that the electrical pressure and counter pressure in the primary circuit of the converter used at Great Barrington were approximately equal, so nearly so that the counter pressure approached in value the applied pressure within one two-hundredth part of its value. All the Great Barrington converters were provided with primary coils within the present issues.

Concluding his opinion, the commissioners says:

"Inasmuch as Slattery did not conceive the invention prior to June, 1886, nor reduce it to practice before December of the same year, it follows that the decision of the Examiners-in-Chief adjudicating priority to Stanley must be affirmed."

Appointments, Etc.

MR. W. B. FERGUSON, late with the Thomson-Houston Electric Company, is now New England manager of the Detroit Electrical Works, the builders of the Rae system.

MR. WALTER N. SPERRY, at present manager of the Waterbury division of the New England Telephone Company, will in addition become manager of the Birmingham division. Mr. Sperry will spend part of his time between both stations. He will, however, have an assistant residing permanently in Birmingham, in the person of R. H. Gray, at present connected with the system in Waterbury.

MR. H. F. PARSHALL, late general manager and electrician of the Wenstrom Consolidated Dynamo and Motor Co., of Baltimore, Md., has found it necessary on account of the ill health of Mrs. Parshall to resign his position with that company. He has now gone South, where he hopes the change of climate may restore to Mrs. Parshall her former health. Mr. L. Atwood, formerly of Chadbourne, Hazelton & Co., of Philadelphia, Pa., succeeds Mr. Parshall as general manager.

MR. W. H. PALMER, formerly of the Thomson-Houston Co., and late superintendent of the Railway Department of the Wenstrom Co., has been appointed electrician of the Wenstrom Consolidated Dynamo and Motor Co., with supervision of the manufacturing and construction. Mr. E. C. Sickles, M. E., who has been for some time with the company is his assistant.

Obituary.

ALBON P. MAN.

The death occurred last week, of Albon P. Man, a leading lawyer of this city and one of the founders of the Sawyer-Man Company. Mr. Man was associated with the late W. E. Sawyer many years ago, in the effort to produce a commercial incandescent lamp, and their work is fully recorded in the evidence brought out by the extensive patent litigations on this subject. He took an active interest in the affairs of the Sawyer-Man Co., for some time after its organization, but of late had been occupied with a variety of other important enterprises.

MILEAGE MADE BY ELECTRIC CARS IN DENVER.

Subjoined is the record made by two electric cars of the Thomson-Houston system operated by the Denver Tramway Co.:

	CAR No. 300.	CAR No. 302.
Feb. 7	201 miles.	201 miles.
" 8	201 "	201 "
" 9	201 "	187 "
" 10	187 "	187 "
" 11	201 "	214 "
" 12	201 "	187 "
" 13	201 "	187 "
Total for week	1393 "	1364 "
Daily average	199 "	195 "

	CAR No. 301.	CAR No. 303.
Feb. 7	201 miles.	187 miles.
" 8	187 "	187 "
" 9	187 "	147 "
" 10	187 "	174 "
" 11	187 "	187 "
" 12	201 "	174 "
" 13	187 "	174 "
Total for week	1337 "	1230 "
Daily average	191 "	176 "

Distance per round trip .... 13.4 miles
Time ....80 minutes

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

If you want to hear how bad trade is, hunt up a man who doesn't advertise.

THE "A. B. C." TRADE CATALOGUE.

THE improvement in electrical trade catalogues is very noticeable this year, more and more money being spent on them and more and more care being given to their contents. We have already had occasion to speak of creditable productions in this line of the present season, and now have before us an extremely artistic and useful publication in the April catalogue of Alexander, Barney & Chapin. Herewith is shown a reduced fac simile of the design on the front cover. The catalogue is in quarto form, 7 x 10 inches, and is beautifully printed. The back cover folds over the front cover in pocket book style, and attached to it at the lower corner is an embossed fac simile of a switch cover and handle, making not only a very striking innovation but serving the useful purpose of a book marker. The catalogue runs nearly 250 pages, and all the apparatus shown is carefully numbered, priced and illustrated. A most commendable feature, moreover, is that of giving very full and explicit descriptions of the leading instruments and devices. This has always been wanting in catalogues of a comprehensive and trade character, and the new departure shows excellent judgment as well as a keen appreciation of the fact that purchasers very often wish to be fully informed as to the special merits and characteristics of the apparatus they are buying. We note that the same idea of giving essential details has been carried out in other lines of supplies contained in the catalogue, rendering it very valuable for reference. The catalogue embodies, further, a number of useful tables of sizes, etc., of different supplies, and is completely indexed. The young house is to be warmly congratulated on its enterprise and success in this effort, which redounds so much to its credit as a representative and progressive supply concern.

A LARGE RAE ELECTRIC RAILWAY CONTRACT.

On March 30, the Common Council of Grand Rapids, Mich., granted the petition of the Valley City Street and Cable Railway Co., whereupon Mr. Chas. A. Benton, the energetic general agent of the Detroit Electrical Works, closed a contract, promptly, with the Company for ten 30 h. p. Rae equipments, mounted on McGuire Mfg. Co.'s steel trucks, the road to be in operation by May 15. This is only a preliminary order, as the total number of equipments required is about 40. The company will eventually utilize the Hamilton Corliss engines, now furnishing power for the cable system, and it is understood that the cable system is not of long continuance. The Detroit Electrical Works have now running just upon 200 street car equipments, a really phenomenal record, in view of the shortness of the time they have been building the Rae apparatus. Mr. Benton is the prouder of the order, from the fact that it was secured in hot competition, and despite strenuous advocacy of the single reduction and "gearless" motors.

MILLIKEN METALLIC POLES.

Messrs Milliken Bros., of New York and Chicago, have issued a pamphlet descriptive of their metallic poles for electric lighting and street railway work. The publication is extremely artistic in its finish, and is handsomely illustrated from photographs. It also contains some useful information for engineers and all others interested in electric lighting plants, in regard to the best methods of construction.

PARTRICK & CARTER CO.

THE above company, of 125 South Second street, Philadelphia, have just issued a large, handsome and complete catalogue and price list of their electrical supplies and goods. They have aimed to make this the best and most complete of the many issued by the house up to date, and flatter themselves, with reason, that they have succeeded. In its pages will be found pretty much everything that can be called for by the user or buyer of things electrical. It also has the merit of careful and well considered arrangement. It will be mailed free with trade discounts on receipt of request for it, accompanied by business card or other evidence that the applicant is a dealer.

The firm have also prepared a very effective and taking "Sample" show board, containing their leading specialties, all connected up in complete working order for practical exhibition, with the customer's name in gilt letters on glass. It is of hard wood, light or dark, as required, and is 15 by 22 inches. The price complete with battery, f. o. b., is only $20. The goods are prettily grouped and the board will make an attractive ornament for any store.

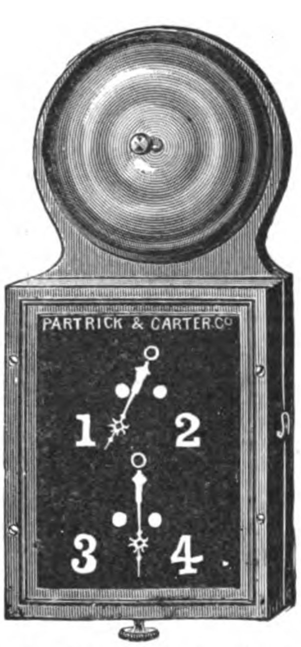


FIG. 1.—THE "INDICATOR" BELL.

In the accompanying illustrations, Fig. 1 shows a modification of the celebrated indicator bell manufactured by this company. It is perfect in all its working parts, and in every way reliable. Fig. 2 shows a view of the "King" bell, which is so made that only the gong is exposed. It is extremely compact, and is so arranged that the hammer is locked and the bell cannot ring, no matter how much shaken, until the circuit is closed. This bell is especially adapted for carriage and railway use.

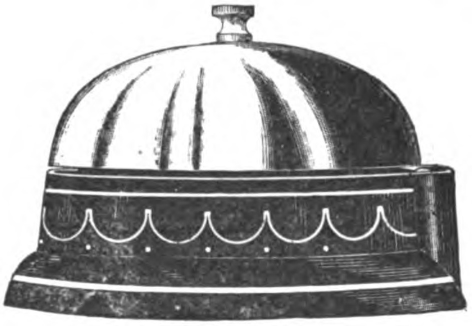


FIG. 2.—THE "KING" BELL.

C. R. VINCENT & CO.

C. R. Vincent & Co., 15 Cortlandt street, New York, have secured contract for complete installation for a 500 h. p. steam plant for the West End street railroad, Lancaster, Pa.

THE PAGE BELTING CO.

The Page Belting Co., of Concord, N. H., with stores at New York, Boston, Chicago and San Francisco, report a very large trade, and largely increased business over one year ago.

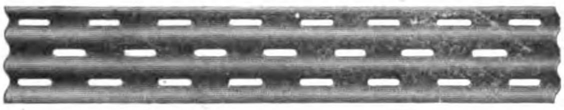
Their patent Acme Link belts are receiving a very large sale, not only for electric purposes, but also, among other things, for driving fans in large iron manufacturing establishments.

Two of these belts, 12 in. wide, have been running in one establishment in Pennsylvania one year, day and night, for this purpose, at a speed of 5,761 feet per minute, thus demonstrating their adaptability for high speed work. Among the orders which they have recently filled is one for some very large belts sent to Omaha, Neb. They have published their catalogue for 1891, which should be in the hands of dealers and users of belting. It contains a full list of all the goods they manufacture. It has a very comprehensive cipher code for use in ordering goods. There is in it an article of great practical value, entitled, "Practical Rules for the Purchase and Use of Belting." The catalogue sets forth in a very clear and explicit manner the kinds and grades of belting which should be purchased for different kinds of work. It also has a valuable appendix, showing a great variety of ways in which belting is applied to the propelling of machinery under extraordinary circumstances.

They have also just issued a neat and useful circular giving directions for putting on endless belts, setting forth the methods in a very clear manner. Among other specialties which are manufactured by this company are "dynamo" double belts. These are double leather belts of great excellence and made with the very best of care and from the best of material. A very neat circular has just been issued by the company describing this class of goods.

CORRUGATED METALLIC LATH.

Nothing spoils the appearance of a new building so quickly as cracked walls and ceilings, and the employment of ordinary wood lath with its uneven shrinkage is the cause of most of the unsightliness of such buildings. Besides, the wood lathing introduces an added risk from fire, which it is desirable to overcome, especially in connection with electric light stations, and to that end the Cincinnati Corrugating Co., of Piqua, O., several years ago brought out a corrugated metallic lath which has from its introduction met with unqualified success.



CORRUGATED METALLIC LATH.

The accompanying engraving shows one style of lath made by this firm, in which the oval perforations are situated at the bottoms of the corrugations. More recently they have introduced a new style with round perforations, which is becoming equally popular. In this the total space for key afforded by the openings is the same as though they were oval, as they are more numerous. They are also made on the sides, instead of at the bottom of the corrugations, thus best preserving the rigidity of the lath and allowing the motor to key at an angle, which gives it a better hold.

Corrugated metal lathing can be adapted to any kind of surface, requires no stretching, and, while possessing great rigidity, can be bent to a semicircle where required for use on curved surfaces. It is economical of plaster, requires no cross furring, and can be used over 24 inch openings without danger of sagging.

This lath is usually made three corrugations wide, and in lengths ranging from 16 to 96 inches, but can be made specially in sheets up to ten feet long, and twelve inches wide. Among the valuable features claimed, is the fact that the mortar adheres firmly to the surface of the metal itself, in addition to the hold given by the perforations, and that it is the only style of lath that can be applied by one man.

NOYE ENGINES FOR THE DETROIT EDISON PLANT.

The Edison Illuminating Company of Detroit, Michigan, have contracted with Fairbanks, Morse & Co., of Chicago, Ill., for a 400 h. p. non-condensing tandem compound engine, built by the John T. Noye Manufacturing Co., of Buffalo, N. Y. This will be an exceptionally fine engine of their "B" type, suitable for heavy duty. Attached to it will be two of the new pattern Edison machines. These machines will be among the first of this size built by the Edison Company.

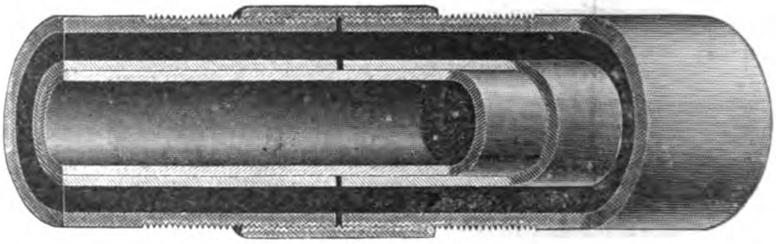
R. T. WHITE'S STREET RAILWAY TRACK SPECIALTIES.

Mr. R. T. White has lately made arrangements with Mr. W. D. Thomas, 141 Byran street, Savannah, Georgia, to act as his Southern agent; Messrs. D. E. Garrison & Co., Laclede Building, St. Louis, Mo., to act as St. Louis and Southwestern agents, and the Great Western Electric Supply Co., 190 and 192 Fifth avenue, Chicago, Ill., as his Chicago and Northwestern agents. As these are very responsible and pushing firms, he expects to be able to sell a large amount of material through them, in addition to the large orders he is now obtaining. He has some very good orders on hand from street railway companies for track material.

INTERIOR CONDUIT AND INSULATION CO.

In order to meet a demand which has arisen for a single duct conduit of cheap, durable and efficient character, the Interior Conduit and Insulation Company have adapted their well-known insulated tubing to fit telescopically into a wrought iron pipe, as shown in the accompanying illustration. The full space between the tubing and the iron is filled in with insulating compound, thus absolutely excluding all moisture and gases. These pipes are made up in 10-foot sections, and, when laid, are coupled together by suitable wrought iron couplings. These sections of 10 feet each are made up in the works, complete and ready for shipment.

In laying, these sections are converted into a continuous duct, having practically no junctions, by employing individual insulated tubes whose lengths are the same as the iron pipe sections, but whose external diameter is slightly less than the internal diameter of tube contained in the iron pipe. These individual tubes are coated at the moment of laying, with an insulating compound or cement and telescoped into the iron pipe section to the depth of just one-half their length in each section. A liberal supply of cementing compound is then placed upon each end of the sections to be joined, and the ends of the iron pipe brought together firmly by a screw coupling. Thus the insulated iron covered duct so formed, of two complete insulating tubes cemented together and held apart from the iron pipe by a lining of insulating compound, becomes, to all intents and purposes, as perfect in its continuity as if manufactured in the factory in one unbroken length.



SINGLE DUCT CONDUIT FOR HIGH TENSION CIRCUITS.

This single duct conduit, as well as the multiple duct system, of the same company, provides in the conduit itself, without special investment therefor, an insulation ample for all purposes, and they are thereby enabled to employ bare copper conductors therein in place of the insulations and metallic protections heretofore used for underground work.

This conduit will be found specially desirable for the use of arc lighting companies and others employing a series system. It will also be found specially desirable for carrying the feeders of electric street railway lines: in fact in any place where a single duct conduit of high insulation is required. By reason of its cheapness and the economy of bare copper wires, it is unnecessary to predict a large and ready market for this admirable conduit.

THE DIRECT UNITED STATES CABLE WINS THE RACE.

The Direct United States Cable Company has again had the satisfaction, it states, of distancing all competitors in the time occupied in cabling the news of the Oxford-Cambridge boat race across the Atlantic. The Direct Company has accomplished this feat so often, it says, that in order to be fair to the other cable companies, it now proposes to handicap itself by conceding them a time allowance.

CATALOGUE OF THE ELECTRICAL ENGINEERING AND SUPPLY COMPANY OF SYRACUSE.

The new catalogue of the Electric Engineering and Supply Co., of Syracuse, is one of the most complete that has come under our notice. It is neatly gotten up, profusely illustrated, and contains over 200 pages of matter descriptive of the electrical and mechanical supplies manufactured by the company, including many specialties. The catalogue also contains a complete cross reference index, which greatly increases its value.

THE STILWELL & BIERCE MANUFACTURING COMPANY.

We take pleasure in calling the attention of our readers to an admirable electric light and railway water power plant recently installed for the Olympia Light and Power Co., at Olympia, Washington, by the Stilwell & Bierce Mfg. Co., of Dayton, Ohio.

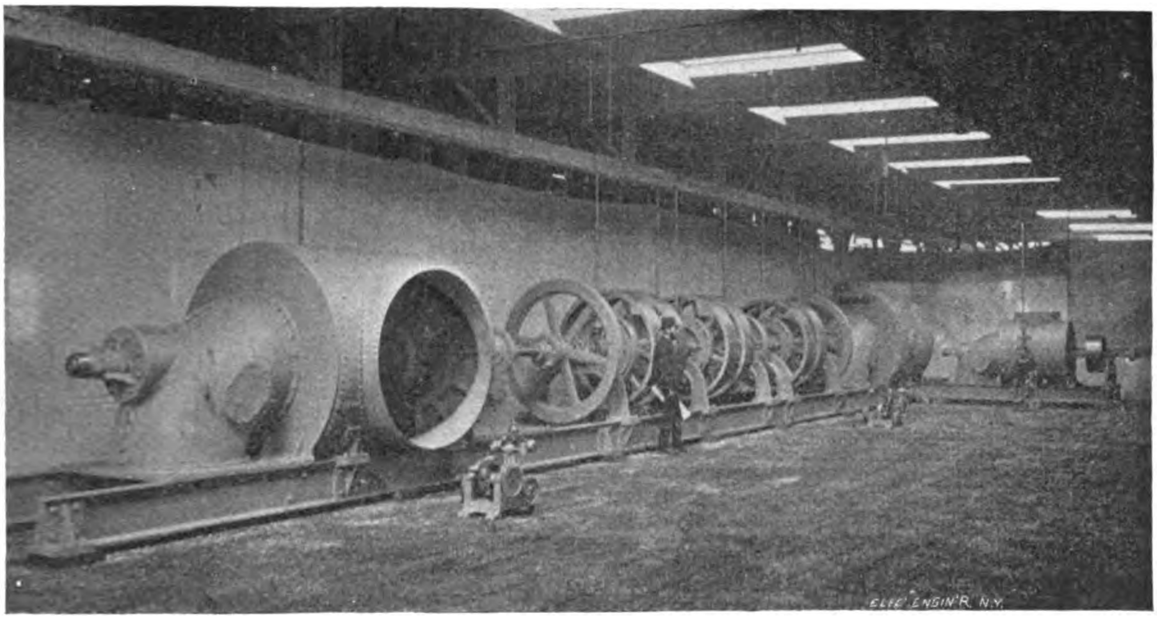
This plant, which is shown in the accompanying illustration, consists of two pairs of 25 inch wheels running on a horizontal shaft under a head of 24 feet, developing 104 h. p. per wheel, or 416 h. p. in the aggregate, and arranged as follows:

One pair of wheels is placed at each end of a line of shafting and the power is taken off by means of 6 friction pulleys on the line; the clutches for engaging them are operated by hand wheels from the dynamo floor above, and by means of a clutch coupling, placed midway between the two pairs of wheels, the line may be run in one or two sections at will.

The water wheels are encased in wrought iron flumes, and are so placed that the shaft is about 10½ feet above the water in the wheelpit, the water discharging through a draft-tube.

The water-wheel gate is operated by a hand-wheel in the dynamo room above. Each pair of wheels has a governor attached for controlling the speed, and there are also two fly wheels weighing 2,800 lbs. each on the shaft.

The features worthy of special attention in connection with this plant are the water-wheels running on a horizontal axis, doing away with all gearing, and the opportunity, by means of the clutch coupling, of supplementing power on either section in case of failure on the other, or of running all or any part of the lighting section from the railroad section, or vice versa.



STILWELL & BIERCE WATER WHEEL PLANT AT OLYMPIA WASH.

The Stilwell & Bierce Mfg. Co. make a specialty of this class of construction, and are building more horizontal wheel work than all other builders combined.

The Stilwell & Bierce Mfg. Co. are proprietors of one of the largest machinery establishments in the West. This enterprise dates back to 1866, and was commenced in a small way by G. N. Bierce and E. R. Stilwell, and this moderate start formed the nucleus from which was developed the enormous business now operated by the Stilwell & Bierce Mfg. Co., which was incorporated in 1870. Their shops occupy a frontage of nearly 1,000 feet, with large rear additions. The mechanical department embraces the heaviest and most modern machinery appliances and tools, most of which is of late introduction, the facilities of the works having recently been nearly doubled in capacity. It is operated by water power with steam power in reserve, and a force of about 350 skilled workman are here given lucrative employment. The establishment is divided into three general departments, each manned by an accomplished engineer with a suitable force of assistants. These departments cover the manufacture of the celebrated Victor Turbine Water Wheels, both vertical and horizontal, in great variety of styles and sizes and power connections of all kinds, their catalogue of gears, pulleys, etc., being very complete and extensive; modern flour mill machinery, including Odell's roller mills, reels, purifiers, etc., the good qualities of which are attested by the number of large first-class flour mills built by them; and devices for heating and purifying the feed-water for steam boilers, prominent among which are "Stilwell's exhaust heater and filter combined," of which over 5,000 are in daily use, and "Stilwell's live steam purifier," a more recent invention which is very successful in removing from feed water sulphates of lime, magnesia and other impurities. Handsome catalogues fully illustrating and describing their various specialties will be cheerfully furnished to all interested parties who will state their requirements and apply to Stilwell & Bierce Mfg. Co., Dayton, Ohio.

THE NEW CENTRAL ELECTRIC CATALOGUE.

We are in receipt of the new catalogue just issued by the Central Electric Co., of Chicago. It is a massive production of generous western proportions, 8 x 10½ inches, solidly and richly bound in colored boards, and running a length of no fewer than 300 pages. Chicago may well be proud of such a concern, the picture of whose large offices and warehouses at 116 and 118 Franklin street, is shown as a frontispiece. The catalogue is divided into sections, and it is interesting to note that the first is given up to incandescent electric light supplies, occupying nearly 80 pages. Then come arc light supplies, which are necessarily less extensive, and then come about 40 pages of "construction material" proper, followed up by 20 more of miscellaneous construction details, including belts, filters, rubber gloves, interior conduits, etc. Next comes an important section headed "tools," and the variety here shown is such as to demonstrate that the electrical business has already become one of the largest departments of the hardware industry. Following this is the section devoted to wires and cables. The Central Electric Co. are general western agents for all the Okonite specialties, and hence attention is given first to these, prefaced by some valuable data as to the nature of Okonite insulation. The Candee wires and Manson tapes are not forgotten in this category, which is succeeded by waterproof wires, magnet wires, German silver resistances, sheet copper, etc. We now come to test instruments, here set forth in admirable profusion and detail in about 25 pages. A large portion of space is then given up to electric railway supplies, household goods, electrical books, underwriters' rules and regulations, wire gauges, tables of resistances, electrical units and a telegraphic code.

A very useful detail in this catalogue is the care that has been taken to place opposite each article a "trade word," by means of which a single word stands sometimes for as many as ten in the catalogue, and avoids any confusion or any necessity for compiling a special code when beginning to order by telegraph for a new contract or installation.

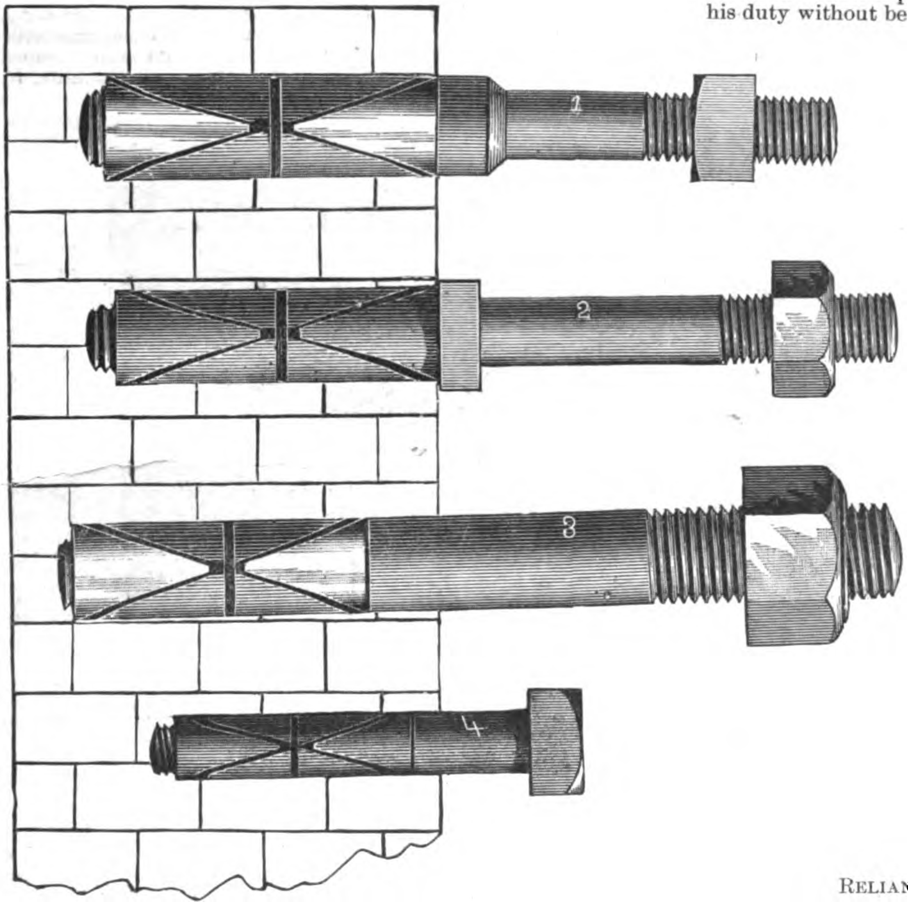
"THE FINANCIAL AND MINING RECORD," of New York, has increased its size to 32 pages, in which form it makes a convenient and valuable publication, and serves as a record and authority for the important fields to which it devotes special attention.

ELECTRIC MERCHANDISE CO.

Mr. Frank X. Cicott, formerly of San Francisco, who carried on a general agency business for eight years in that city, in the electric supplies and railway material, has assumed the management of the rail department of the above company, who are the selling agents in connection with their regular business for the Tramway Rail Company, Pittsburgh, Pa., manufacturers of girder, tram and T rails as well as street railway equipments generally.

AHLSTROM'S PATENT EXPANSION BOLTS.

In places where it is necessary to fasten and suspend wires from masonry and stone walls, it is very difficult to secure the necessary fastenings. The method now in vogue is to drill a hole, put in a tight-fitting wooden plug, saw it off so that it will be flush with the surface, and then drive a nail or screw into it. This is difficult and sometimes expensive. To avoid this, Mr. J. C. Ahlstrom, of Brooklyn, has recently invented the new expansion bolt shown in the accompanying illustrations. There are a great many places in connection with electrical construction works where a bolt of this kind can be used. All that is required with the expansion bolt is a hole of sufficient size and depth to insert it. Then by turning the head, as with a common bolt, the parts of the sleeve are drawn towards each other, which causes them to bind parallel in the strongest manner possible. It will also be seen that the greater the force brought on the bolt the tighter will be the grip. These bolts can be removed with ease and facility, and applied without injury either to the masonry or the bolt itself.



Ahlstrom's Expansion Bolts.

W. C. Boone & Son, 394 Broome St., this city, are the manufacturers. There will no doubt be a wide application of this bolt in connection with electrical construction.

THE WORLD'S FAIR ELECTRICAL EXHIBIT.

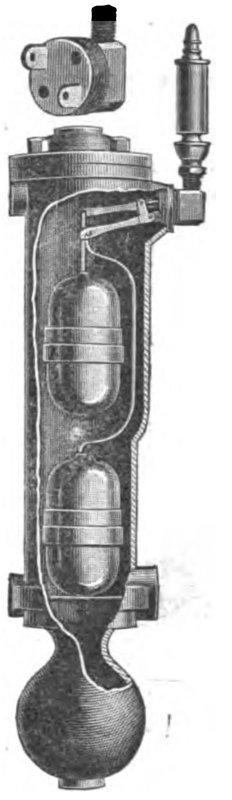
Professor John P. Barrett has made several changes in the classification of the department of electricity and electrical appliances at the Columbian Exposition, as arranged by Mr. M. H. De Young, whose arrangement he asserts is far behind the times from a practical point of view, although a good one scientifically considered.

THE RELIANCE SAFETY WATER COLUMNS.

The accompanying illustration represents an automatic high and low water alarm manufactured by the Reliance Gauge Company, of New York, Cleveland and Chicago. As will be readily seen from the engraving, a bell-crank lever connects the lower float rod with the whistle valve, and, with the water at the proper height, the solderless copper float attached to this rod is submerged, and, pressing upward, holds the valve closed, but when the water from any cause whatever, such as leakage, stopping of injector, breaking of pumps, or carelessness, gets low enough to rob the float of its support, it sinks of its own gravity, thus opening the valve and blowing a whistle.

The high water alarm is simply the low water alarm reversed. A bell-crank lever is turned over so that the weight of the float holds the valve closed until the water rises and carries the float up with it, thus opening the whistle valve. It is impossible for the water to pass either the upper or lower gauge cock without automatically blowing the whistle.

These appliances, which have been in use for over six years, are simple, complete, durable and accessible. There is nothing about them to get out of order and they have neither stuffing boxes nor fusible plugs. The fireman cannot seriously neglect his duty without being exposed by the whistle, and as a natural consequence he keeps one eye on the water all the time and carries it at the proper level, thereby saving fuel, repairs and stoppage, and prolonging the life of the boiler by protecting it from low water, while protecting the engine from high water. They prevent mistakes when the boiler foams, when the pump works poorly, when the water glass is stopped up, when breaking in new men, at night when the watchman is in charge, and in the morning when getting up steam.



Reliance Automatic Water Column.

S. H. PARVIN'S SONS.

Forty years ago the newspaper advertising agency of S. H. Parvin's Sons, 132, 134 and 136 Vine street, Cincinnati, was established, and the concern has recently been enjoying the congratulations of its numerous friends. It has handled the business of many advertisers continuously for a period of at least a quarter of a century, and bids fair to handle it for another 25 years; while its relations with a large number of technical and trade journals extend over a long series of years, with satisfaction and growing respect on both sides. The anniversary has been appropriately commented upon by the Cincinnati daily papers, whose complimentary remarks will be gladly echoed by all the periodicals with which the house has had dealings during its long and honorable career.

MAGNETIC VANE AMMETERS AND VOLTMETERS.

THE accompanying illustrations represent the latest improvements in station ammeters and voltmeters brought out by Queen & Co., among their "magnetic vane" instruments.

The construction of these instruments has been somewhat changed since they were first placed on the market; various improvements being incorporated which render them of even greater value as station instruments, although they have been largely used for such purposes as ordinarily made. The peculiarities of the "magnetic vane" ammeters and voltmeters, which are held to recommend them to electrical engineers are: low prices, absence of permanent magnets, accuracy, strong construction and handsome appearance.

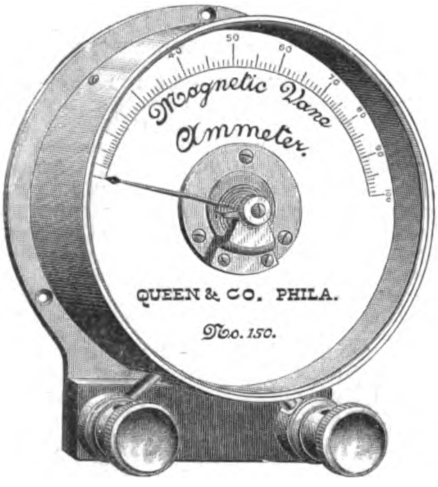


FIG. 1.—MAGNETIC VANE AMPEREMETER.

The "magnetic vane" instruments are not claimed to be absolutely accurate, but they are claimed to be quite accurate enough (within one or two per cent.) for commercial purposes. The instruments contain no delicate parts liable to injury, but are of good, solid construction, and in consequence are well adapted to the usage which station instruments necessarily receive. The voltmeters as well as the ammeters, can be left in circuit, and may be fastened permanently on the switch board if desired.

The "magnetic vane" instruments are designed especially for central stations, isolated plants, marine installations and railway work and are well adapted for general experimental work. For central stations the large size ammeters are used as they have fine open dials 8″ in diameter, and have special cut out plugs, so that they can be left in circuit, or not, as desired. They are made to measure currents of any desired quantity, though 500 amperes is the largest size in Queen & Co.'s catalogues. The smaller ammeters, Fig. 1, are suitable for isolated installations, and are so low in price that they can be economically used on the most inexpensive plants. In marine work, where space is limited, the ammeters and voltmeters must not be affected by proximity to the dynamos or the motion of the vessel. The "magnetic vane" instruments have been largely used for such work with most satisfactory results. The voltmeter, Fig. 2, is intended for electric railway engineering, and will be found a most valuable instrument. It is calibrated up to 600 volts, and has a special short circuit key for rapid work.

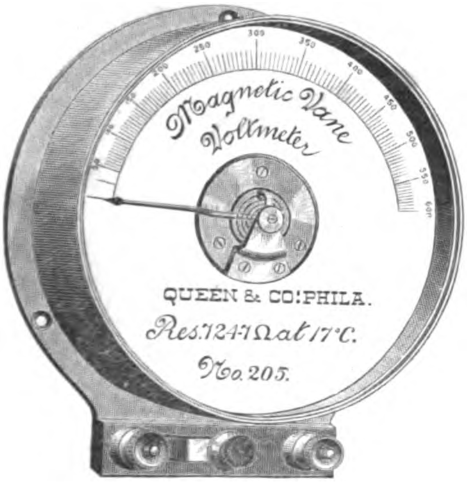


FIG. 2.—MAGNETIC VANE VOLTMETER.

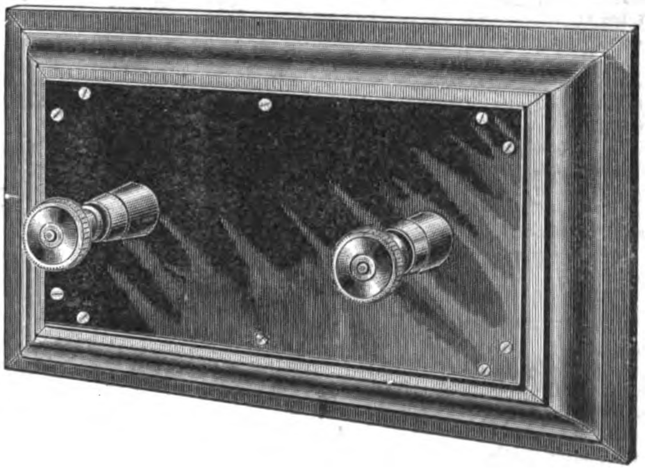
Queen & Co. have just issued their circular No. 235, fully describing their magnetic vane ammeters and voltmeters, and those interested in the subject will do well to send for a copy. It contains numerous testimonials supporting the claims made by the makers.

MEGOHM PLATES OF THE E. S. GREELEY & CO.

WITH the electrician whose duty it is to go about from station to station or from point to point, making tests wherever they may be required, the objection to the ordinary megohm box has not been simply that of expense. The question of ready portability has been a factor in deciding against the very high resistance box, notwithstanding its greater usefulness.

Now, however, with the advent of the English megohm plates shown in the accompanying illustration, a thoroughly handy, convenient and reliable megohm resistance is available at a much smaller cost than a one-tenth megohm wire box.

The portability of the megohm plates will be best appreciated upon taking into consideration the measurements and weight of the instrument. It is only 9 inches in length by 7 in width, and, exclusive of the binding posts, 2 inches in height. The binding posts, however, as is customary, stand 2 inches above the base of the instrument. The whole weight is about 3 pounds.



MEGOHM PLATE.

As evidence of the permanent character of the instrument, it is stated that Mr. David Brooks, of Philadelphia, has had one of them in use for ten years without any perceptible variation in the resistance, he having had it tested frequently at his laboratory throughout this period of time.

This instrument, though comparatively new in this country, is well known in England, where it has been in appreciative use for a number of years. It consists of a conductor of high resistance material, baked into plates of glass, which thoroughly protect the circuit from moisture, and the resistance of the instrument is not materially affected by atmospheric changes or temperature.

The employment of this high resistance instrument will permit of the same battery being used in making both the actual test and in taking the constant, and will thus reduce the opportunities for error that are otherwise apt to arise from the calculation of a battery ratio and from employing low resistance shunts as a consequence of the frequent practice of taking the constant through 10,000 and 100,000 ohms.

These standards range from 1 to 5 megohms, being calibrated as near to the unit as practicable. The definite resistance is marked on the face of each instrument in legal ohms, but the temperature, not being a factor, is unrecorded. The plates are mounted in polished mahogany cases with hard rubber tops and convenient binding posts.

This instrument is placed upon the market in this country by The E. S. Greeley & Co., of this city.

TELEPHONE PROGRESS is demonstrated by the fact that an exchange will soon be opened at Mandalay Straits Settlement. That at Cawnpore, India, is nearly ready to begin operations.

"ENGINEERING."

This is the name of a handsome new monthly periodical, the first number of which has just been issued for April from the offices, 124 World Building, this city. It is in octavo form and consists of 138 handsomely printed pages. There are a number of signed articles on engineering topics of interest, one by Mr. H. L. Webb, dealing with the possibilities, or rather the improbabilities of ocean telephony. There are also a number of well edited special departments summarizing the technical and engineering work of the month. The price is 25 cents per copy and $3 per year. The editor is Mr. J. R. Dunlap, who is to be congratulated upon this highly promising debut of the new magazine.

THE WOODBRIDGE & TURNER ENGINEERING CO.

The Woodbridge & Turner Engineering Co. has been organized as successor to the firm of Woodbridge & Turner, with Wm. S. Turner as president; Geo. A. Bell as vice-president, and J Lester Woodbridge, as secretary and treasurer. The company will occupy offices at 47 *Times* building, New York city, and to it will be turned over all new business of the firm, together with their entire stock of tools, supplies, apparatus, etc. It is their purpose to extend the scope of the business of the firm, in electric railway and electric light engineering.

The company will conduct a consulting and constructing engineering business. They will furnish plans, specifications, and estimates, supervise construction, and enter into contracts for the equipment of electric railways and electric light plants, in full or in part, including steam plants, line construction, track building, generators, motors, and cars. The company will be conducted under the same management as the old business, which was established with the building of the first commercially successful electric railway in the United States; and they feel that they bring to the company, together with their force of co-workers, a knowledge and experience equal to the demands of the business which has grown so remarkably.

It is the purpose of the management to retain the high standard of workmanship in all departments which it has heretofore been the endeavor of Woodbridge & Turner to sustain, and to merit a continuance of the good will and confidence which has hitherto been reposed in them.

A NOVEL ELECTRIC ELEVATOR.

The Keystone Electric Company, of Erie, Pa., have just completed a novel and ingenious electric elevator which they will shortly place upon the market. The details of the combination have all been worked out in the best and simplest manner, and possess many new and advantageous features which will at once commend it to those requiring such an outfit. The operation is very perfect, the motor being entirely free from sparking, heating, or other undesirable features which are a constant source of trouble when they exist. The motor handles the elevator by means of a belt from the pulley on the wind-shaft to that of the motor which only runs during the time that the platform is moving.

THE BOSTON TROLLEY AND ETNA INSULATORS.

Messrs. Albert & J. M. Anderson have entered into an agreement with the Engineering Equipment Company, of 78 Cortlandt street, New York, by which the latter Company become the representatives of the Anderson line materials, which include the well known "Boston Trolley," the trolley wire hanger, the "Etna" insulators, and all other materials for the equipment of electric roads, which are manufactured by the Messrs. Anderson.

The Engineering Equipment Company are the authorized agents for the sale of these excellent line materials, and the trade will be given the facilities and prices in all dealings they may have through this agency. The Engineering Equipment Company, who are now in temporary quarters, will remove during April to their new officers in the Central Building, foot of Liberty street, New York.

WESTERN TRADE NOTES.

THE ILLINOIS ELECTRIC MATERIAL CO., celebrated the opening of their spacious and handsome new store at 158 Fifth avenue, on April 1, in a very fitting and appropriate manner. All through the day a host of callers dropped in to congratulate the genial Messrs. Winston, Hoefer and Clark on their new quarters, and the thirsty ones found it was "no April fool's day there," after taking an observation of Mr. Ernest Hoefer's private office. It was whispered that the Baron had lined himself for the occasion with "canvas jacket."

MR. W. A. WILLARD, till recently connected with the Interior Conduit and Insulation Co., as their general sales agent, has associated himself with the Chicago office of the Edison General Electric Company as auditor.

MR. ALFRED M. WALTER has resigned his position with the Great Western Electric Supply Co., and accepted a similar one with the Illinois Electric Material Co., and will look after their metal-selling business. Mr. Walter is a pusher, active and energetic, well versed in the supply business, and both the company and himself are to be congratulated on the new connection.

MR. E. G. WILLINGHAM, the manufacturer of insulator pins, brackets and cross-arms, of Chattanooga, Tenn., was a recent welcome visitor to Chicago and returned south with his pocket-full of orders, large and small.

BUFFALO TRADE NOTES.

A NOVEL PULLEY COVERING.—A very reliable and inexpensive pulley covering has recently been brought out by the Burt Pulley Covering Co., 385 Washington street, Buffalo, N. Y. It is known as Brazilian gum pulley covering, and is applied by means of a brush to the pulley, four coats being put on. After the last coat is on, the gum is allowed to harden for 12 hours and then the face of the pulley is oiled with castor oil or any good belt dressing and the belt put on. This covering is guaranteed to prevent slipping of the belt and is as simple as it is efficacious. Numbers of pulleys have already been covered, among others those of the Rochester Electric Light Co. and the local Edison and Brush Co's, where it is giving the most unqualified and entire satisfaction.

A PROMINENT SUPPLY HOUSE.—The American Electric Supply Company, of Buffalo, N. Y., are doing a remarkably brisk business in general electric light and power supplies, and are also doing quite a large amount of construction work. They have just added a full line of combination fixtures to their stock, and are carrying a very complete stock of electrical apparatus of all kinds. Their growth, since starting in business, has been remarkable and is due to the careful and prompt attention given to their business. They have just doubled their capital stock, and are now in a position to handle as much business as any supply house in the country.

THE BUFFALO SPECIALTY MANUFACTURING CO., 67 Washington street, are placing upon the market a very excellent belt dressing, termed the "Electric," which is compounded upon scientific principles, and is highly beneficial to a belt. It contains no ingredients injurious to leather. The surface of a belt occasionally dressed with it is rendered smooth and glossy, transmitting largely increased power, keeping the belt pliable and in nice shape, and making it last very much longer. These are important features, and belt users should write for a sample.

NEW YORK TRADE NOTES.

THE TROY ELECTRIC DYNAMO CO., manufacturers of the Winkler dynamos for lighting and power, 535 River street, have perfected their apparatus and will be ready to place their goods on the market soon. Justice Miller is president; W. E. Hartwell, vice-president; Wm. L. Hall, secretary and treasurer.

THE ROBINSON ELECTRICAL WORKS, 478 Broadway, Albany, do all kinds of electrical construction and engineering work. They are to fit up the new Delaware and Hudson Canal Company's building at Albany, which, when finished, will be one of the largest and most complete buildings in that place.

MR. E. A. DUMM, of Chatham, N. Y., makes all sorts of castings. A recent visit to his foundry found him loaded up with business and working overtime to fill the orders he had on hand.

ZUCKER & LEVETT, 46 Murray street, New York City, deal in all sorts of supplies needed in electro-plater's work. They expect to have their Hercules motor ready for the market in the near future.

MR. A. T. BROOK, of 102 Chambers street, this city, is selling agent for the Uniform Drawn Steel Company, of Beaver Falls, Pa., who make a superior grade of steel shafting. They make the very smallest as well as all of the larger sizes.

ELIZABETHPORT CORDAGE COMPANY, 46 South street, this city make twine and rope which is used very largely in this industry. They manufacture a twine which is specially adapted for rewrapping of field coils of dynamos and motors. Wrapping the fields of a dynamo electric machine with twine is the best means of protecting it and they make a specialty of twine for this purpose.

DIEHL & CO., 385 Broadway, this city, who handle the Diehl motor fans are getting ready for the summer's work and Mr. F. H. Tobey, manager of this concern, anticipates a rushing business during the coming summer.

THE JOS. DIXON CRUCIBLE CO., of Jersey City, manufacture a belt dressing for leather belts which adds very much, to not only the life but to the effective working of a belt, as it prevents slip. This is a very good feature in running a dynamo.

THE
Electrical Engineer.

VOL. XI. APRIL 15, 1891. NO. 154.

PROF. THOMSON'S NEW ALTERNATING GENERATOR.

OUR readers are already aware[1] that among the many devices upon which Prof. Elihu Thomson has been at work is an alternating machine in which no wire whatever is moved, the changes in the magnetic condition being brought about by a revolving multipolar magnet energized by stationary coils on either side of the axial core. This machine in its latest form is clearly illustrated in the accompanying engravings, Figs. 1, 2 and 3.

The alternater has recently been subjected to some preliminary tests at light loads by Mr. Ekstrom, of Prof. Thomson's laboratory, and the results obtained, which are given below, may, therefore, be subject to some revision when the tests are fully completed.

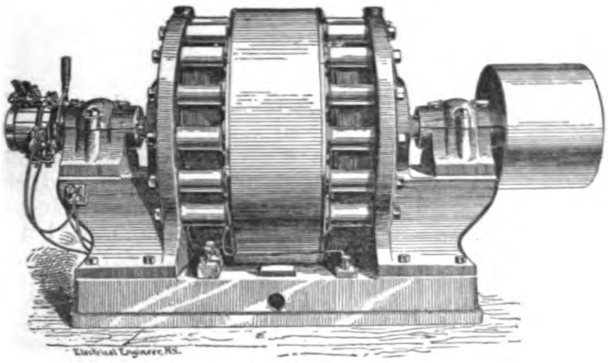

Electrical Engineer, N.Y.

FIG. 1.—PROF. THOMSON'S NEW ALTERNATOR.

The principal data regarding the construction of the machine are as follows :

Weight of machine, total	8,800 lbs.
" " separately excited field wire	440 "
" " series field wire	311 "
" " armature wire	93 "
Watts outputs per pound weight of dynamo	9 watts.
Power required for separately excited field	910 "
" " " series field	386 "
Resistance of armature	.008 ohm.

The loss in the armature conductor at a load of 75 amperes is 621.6 watts ; with an output of 79,500 watts, therefore, the electrical efficiency of the machine would be 97.65 per cent.

As stated above, the efficiency tests of the machine are not yet completed, but it has been run by a direct current motor without load and with its field excited, the losses in the direct current motor being known ; and the result shows that, adding the energy used in the separately excited field, and also the energy consumed in the series field, and the $C^2 R$ loss in the armature conductor increased 20 per cent. on account of the increased temperature, the machine will give a total commercial efficiency of about 93 per cent. which, it will be seen, is a very excellent result.

The estimate of efficiency given above assumes that the loss in the armature iron will be the same at light or full load, which, of course, may not be an actual fact. Dynamometer tests will shortly be undertaken.

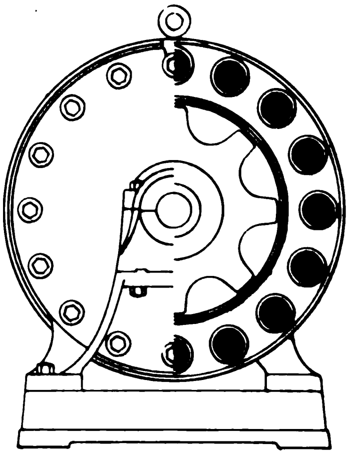


FIG. 2.—PROF. THOMSON'S NEW ALTERNATOR.

Among the mechanical features of the machine is that of interchangeability of the parts end for end, so that the pulley may be put on either end of the machine, the revolving body reversed in position in the machine, and the rotation of the machine made in either direction, without in any way affecting the conditions of output.

Prof. Thomson's high period type alternator, of which mention was made by him in these columns recently, is of the same design, but with 100 armature coils and 50 divisions in the revolving field poles. It gives 1,000 volts alternating potential. The type of machine is one which lends itself easily to the production of rapid alternations, as it only depends on the number of coils arranged around the revolving field pole and the number of divisions in that pole.

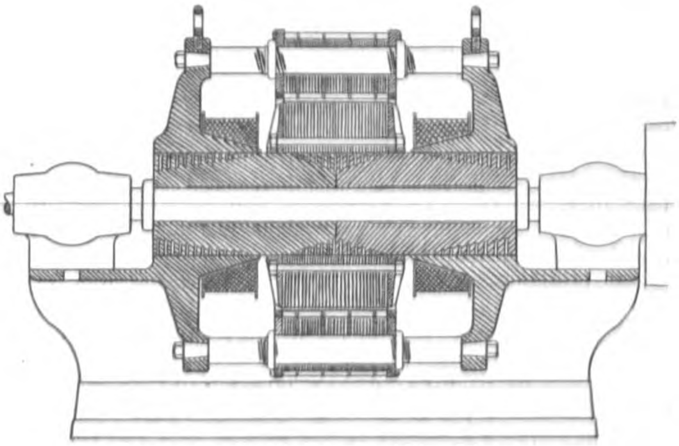


FIG. 3.—PROF. THOMSON'S NEW ALTERNATOR.

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[1] See THE ELECTRICAL ENGINEER, July 30, 1890.

RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.—III.

(Concluded.)

BY

Carl Hering.

WIRING FORMULÆ, THEIR DEDUCTION AND USE.

When a current passes through a wire, there is a gradual loss of voltage along the whole length of the wire. This loss, from Ohm's law, is equal to the product of the current and the resistance, that is,

$$E = C R$$

Now, the resistance of a wire is equal to,

$$R = \frac{l}{d^2} 10.605$$ [1]

in which R is in legal ohms, at about 75 to 80° F.; l is the length of the wire in feet, d is the diameter in mils (or d^2 the cross section in circular mils).

From these two formulæ it follows that

$$E = \frac{10.605\ C\ l}{d^2},$$

from which the loss in volts can be determined for any current, length and diameter of wire. As the circuit is usually a loop or return circuit, it is simpler to use the distance, or length of this loop, represented by D. Furthermore, as the loss is usually known, while the diameter is what is required, the formula reduces to the form

$$d^2 = \frac{21.22\ C\ D}{E}$$

in which D is the distance in feet, from the dynamo to the lamps or motor, for instance.

For arc light circuits this formula is in its simplest form, and for motor circuits also, after having first determined the current C, which is equal to 746 times the horse power divided by the voltage of the motor, or which may be found from tables.

For incandescent lighting this formula may be still further simplified by substituting the number of lamps n for the current C, in which case it is necessary to introduce the constant c, which is the current required by one lamp. This is usually multiplied once for all by 21.22 giving what is usually termed the "constant" for calculating the leads for that lamp. The formula then becomes

$$d^2 = n\ D \times \frac{(21.22 \times c)}{E},$$

in which the quantity in parentheses is the "constant" calculated once for all. This constant is then divided by the actual loss in *volts* E (not in per cent.), which gives a new constant, but for that loss only. The calculation is, therefore, as follows: *Multiply the number of lamps by the distance in feet and by the constant* (which constant has first been divided by the loss in volts). The answer is the cross section in circular mils. From a table find what gauge number this corresponds to, or from a table of squares or square roots, find the diameter in mils of which this is the square.

If lamps of different candle power (and therefore of different currents) are used together, it is best to reduce them all to the equivalent in one size, or else find the total current in amperes and use the original formulæ in which the current is used, instead of the number of lamps.

The loss is often given in per cent. instead of in volts. To find what this is in volts, it is necessary merely to multiply the voltage of the lamp V by the per cent. (in whole numbers, thus: 2 per cent.) and divide by 100. Or, to bring this all into the formula, gives

$$d^2 = n\ D\ \frac{(2122. \times c)}{\%\ V}$$

in which V is the voltage of the dynamo, and $\%$ is the loss in per cent. (in units, thus, 2).

Instead of giving the cross section in circular mils, namely d^2, the formula might be made to give it in square mils, but the very good practice of using circular mils instead of square mils, has become so universal, and is so much simpler, that the other is no longer to be recommended. To change the above formulæ so as to give the answer in square mils instead of circular mils, multiply the numerical constant by .7854, and change d^2 to a.

From the above explanation regarding the "constant" anyone will be able to calculate the constant for any make of lamp. It is always best to do this oneself, unless one is very sure what the constant, given by the makers, means. To determine the constant it is necessary to have the current required for one lamp; whenever possible it is best to measure this for a batch of 10 or 100 lamps, as the figures given by the makers are sometimes considerably below their true values.

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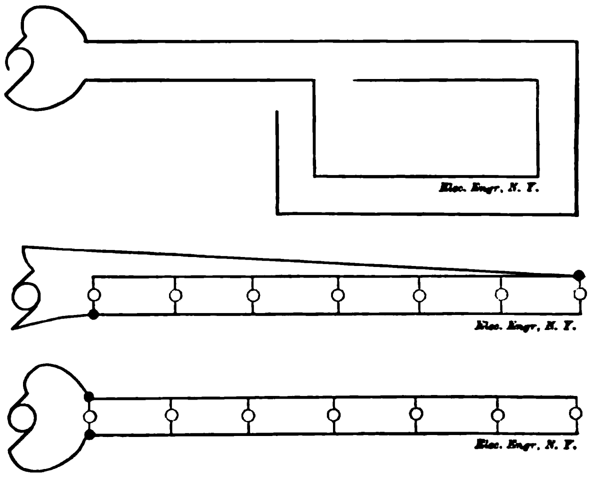
[1] This constant is in accordance with the new Matthiessen standard suggested by the Committee of the Amer. Inst. of Elect. Engineers.

RULES AND FORMULA FOR INCANDESCENT LAMP WIRING.

BY

Osborn P. Loomis

In an article by Carl Hering on the above subject, published in THE ELECTRICAL ENGINEER, of April 1, I observe a statement that needs correction. The author, in illustrating the various systems of distribution, and showing the several difficulties that are encountered, gives a diagram (Fig. 3), and states that all the lamps between this pair of leads will have the same potential. This diagram which is shown in the accompanying Fig. 1 will, on close inspection, resolve itself into the arrangement of Fig. 2, the dynamo leads being, of course, neglected. Now it is very evident that the middle lamp will get less potential than the end ones, and although this variation is much less than in the arrangement shown in Fig. 3, it could never be construed into uniformity. A little study will convince one that no system can be devised to produce that result in the sense of being theoretically perfect, although commercially they may be quite so.



FIGS. 1, 2 AND 3.

THE QUACKENBOSS DIRECT-ACTING ELECTRIC ELEVATOR.

About ten years ago, it will be remembered, Dr. Werner Siemens conceived the idea of operating an elevator by means of an electric motor carried upon the car and engaging, through a spur gear, a rack that extended from top to bottom of the shaft. This arrangement, although operative, was found to be very uneconomical on account of the excessive friction introduced by the gearing. A stationary motor, placed at the bottom of the shaft, or at the top, as is the present practice, while effecting an economy of power over hydraulic and steam elevators, yet, it is claimed, leaves unsolved what must ever be the problem of paramount importance, that of perfect safety.

It is a fact well-known to engineers that the moment a car is elevated, it is necessary to introduce an additional factor of safety—thus calling into existence safety clutches, friction clutches, etc. It is necessary to use several wire ropes attached to the hoisting cylinder or drum, and also to the counter-balance; in fact, large and progressive manufacturers have spared neither time nor money in their efforts to avoid accidents to the passengers using their conveyances, and the small record of such accidents, proves the success of their efforts.

The direct acting electric elevator, shown in the accompanying illustrations, is apparently the outcome of Dr. Siemens' experiments, but, on closer examination, will be seen to embody a totally different principle, being the invention of Mr. P. P. Quackenboss, of New York.

As will be seen, the motor A is suspended under the body of the car and is connected by a peculiar gear attachment to the gear-wheels, B. This motor is equivalent to about 3½ electric h. p., and by a simple method of switches, circuit breakers, etc., will move the car up or down or bring it to a stop. The motor, as shown, is attached to the under side of the car by bolts, mounted upon rubber gaskets to avoid vibration, and can be wound for any current and speed.

The gear-wheels, B, as shown in Fig. 2, grip the guy ropes in such a manner as to obtain the strongest grip with the least strain on the rope, and move up or down only when actuated by the motor through the gear. This adds still another factor of safety to those already in use, the gear being automatically locked whenever the motor stops, so that, if at any time the current is automatically broken, no further inconvenience need be feared than a stopping of the car.

Here another feature of the system comes into play, for, should such a stoppage occur, the attendant in the elevator simply attaches a crank to the gear and winds it up, or down, until a point is reached where the passengers can alight with comfort.

The guy-ropes, C, may be placed opposite to each other in the centre of the car or diagonally at the corners, and may be two or four in number, as desired, two, generally speaking, being sufficient for house purposes. They are kept taut by bolts at each end and are in reality flexible rails on which traction is secured by an increase of friction that does not greatly retard the speed.

Mr. Quackenboss' system thus has the advantage of adding two new elements of safety, in addition to which the apparatus takes up less room, and is claimed to cost less to install and maintain than any other system now in use. Where current can be obtained from a central station no engine or boiler are required on the premises.

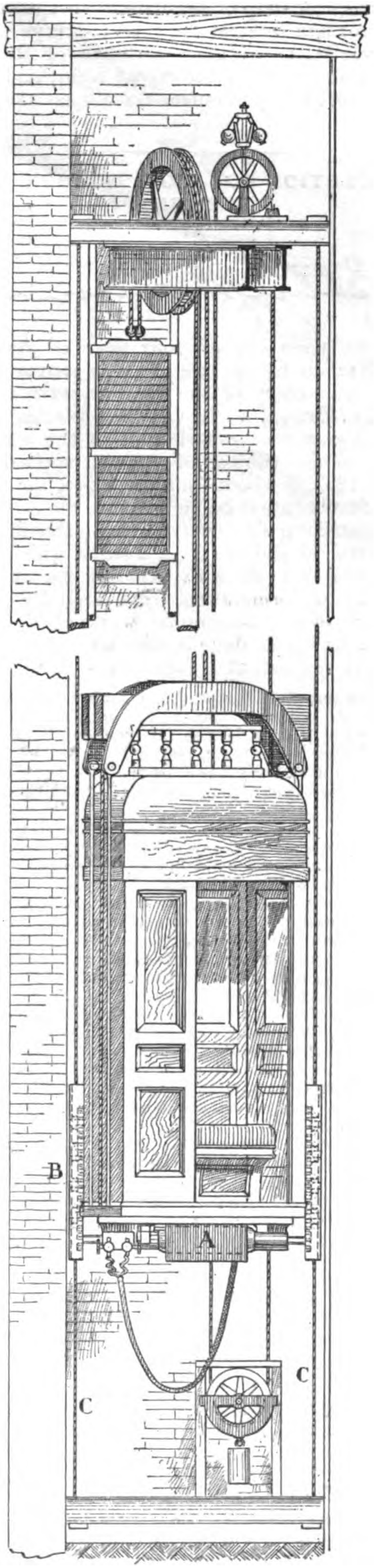
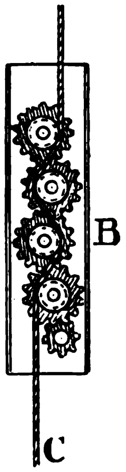


FIG. 1.—QUACKENBOSS' ELECTRIC ELEVATOR.



MICRO-SEISMOGRAPH.

PHOTOGRAPHIC registration has been advantageously substituted by M. Baratta for the mechanical apparatus hitherto used for the registration of the indications by the micro-seismograph of the vibrations of the earth. A microphone placed in the ground is connected to an ordinary telephone; the diaphragm of this receiving telephone is connected by an aluminum wire to a small plate of the same metal carrying a concave mirror movable around a horizontal axis. A strip of sensitized paper is uncoiled before the mirror and receives the reflected rays of a lamp. The small variations of the membrane of the receiving telephone are amplified by the ray of light, and the trace of this ray is left in a permanent trace upon the sensitized paper.

OIL INSULATION FOR HIGH TENSION TRANSFORMERS.

BY

Elihu Thomson

I notice on page 410 of your issue of April 8, that reference is made to the use of oil in converters, in connection with an account of the high pressure experiments of Mr. C. E. L. Brown, at the Oerlikon Works. It may be interesting to your readers to learn that the use of oil in converters was the subject of a patent applied for by me on May 9th, 1887, or about four years ago, the number of the United States patent being 428,648.

There is a striking similiarity between the figure of the patent referred to and the Figs. 2 and 3 which you reproduce describing Mr. Brown's experiments. I have used converters or transformers immersed in oil for quite a time past, and some of the commercial work of the Thomson-Houston Co. has been done in that way under my patent.

I quote from the patent as follows :—

> "The convective fluid for small coils may be air only; but I much prefer to use oil, preferably mineral oil of a non-volatile character, which is also an excellent insulator. Oils of the paraffine series are suitable, especially those of high boiling point. Paraffine wax may itself be used as the filling, as upon slight heating it melts and becomes fluid, acting thereafter as an oil.
>
> "A mixture of paraffine wax and mineral oil is good, for when cold it is buttery or semi-solid, but when warm, it becomes perfectly fluid and convective, while during the warming much heat is rendered latent by melting the paraffine present."
>
> "The immersion of the induction coil in such an oil gives great advantages in keeping out all moisture, in avoiding the necessity for other insulation on the copper wire of the coil than the cotton or other porous covering which becomes permeated by the oil, and in transferring heat by convection from the body of the induction coil to the external iron casting, by which latter it is, on account of the large surface exposed to the air, dissipated. Besides these advantages the casing may be so covered or slotted that it can be exposed to the weather without risking the insulation of the coils. Ventilated coil casings in foggy or very rainy weather so exposed may easily become leaky and cause, through access of moisture to them along with the entering air, a loss of insulation of the enclosed coil."
>
> "The casing which I use is, of course, inclosed or made tight, or is suitably constructed to prevent escape of fluid or access of water. When the coil is placed in it the whole is heated to the boiling point of water, or a little above, to drive out all moisture from the casing and enclosed coil, and cause the oil to throughly permeate the spaces."

CONVERTING AN ARC LIGHT PLANT INTO AN INCANDESCENT PLANT.

BY

Harry Alexander.

The conversion of an arc light plant into an incandescent without altering the dynamo in any way, which was recently carried out by the writer, may prove of interest to the readers of The Electrical Engineer.

Shortly after arc lighting was introduced, the firm of J. B. & J. M. Cornell introduced the electric light in their large iron works in New York city, for which purpose the Weston machine was installed. This machine, of 10 arc lights capacity, was at that time built with 12 coils, and generated a current of 20 amperes at 300 volts. On account of the peculiar construction of the building and the nature of the work carried on in the shops, it was deemed necessary to secure a more even distribution of light, and to secure this end, it was determined to introduce incandescent lamps, but to retain the dynamo, if possible.

The change was successfully carried out, in the following way. Bernstein series lamps were substituted for the arc lamps and run in five branches, with eight lamps in series in each branch, making 40 lamps in all.

The lamps, which take 4 amperes and are of 50 c. p. each, are run in double rows in each of the four sections in the shops, each section being 50x250 feet; making the lamps on the average about 25 feet apart and about 15 feet high. Each lamp is supplied with a 19 inch enameled reflector, which throws a bright, steady light in all directions over the full area illuminated. The lamps are easily controlled by a safety branch board at the main line. The wiring is run on porcelain insulators throughout, Okonite wire with braided insulation being used.

The change in the method of illumination has met with the general approval of the workmen, and a second, larger machine, will soon be changed over to the new method of illumination.

MUNICIPAL ELECTRIC LIGHTING PLANTS.

BY

M. J. Francisco

The April 1st number of The Electrical Engineer reproduces and criticises the familiar list of cities owning municipal plants. This list has proved a veritable will-o'-the-wisp, leading its votaries deeper and deeper into the labyrinths of political necromancy. It has been used by the advocates of municipal ownership in every case where the question of street lighting has been heard, and special stress is always laid upon the remarkable results achieved in Chicago.

I have shown in these columns, and also before the Committee on Manufactures of the Massachusetts Legislature, that the statements made by the superintendent of lighting in Chicago and other places were incorrect and could not be sustained. What an anomaly, that men who claim to be working for the good of mankind, should inaugurate their reform by a scheme of concealment in regard to the true cost of the lights! Experience has demonstrated many times that nothing is gained in the end by this kind of subterfuge. If the lights can be produced by city authorities at less price than private companies can furnish them, show it fairly and plainly by giving the full cost and facts, and there is not a man connected with the electric lighting business who will not cheerfully acquiesce in and approve of municipal ownership. But when a large share of the cost of producing the light is charged to other departments and the true cost concealed, and the private corporations branded as "grasping monopolies" because they do not furnish the light at such price, it looks as though it was political jugglery, instead of political economy.

The writer, at the Cape May convention, proved conclusively that $69.35 per lamp per year was not the true cost of Chicago's electric lights. The annual report of the comptroller of Chicago, signed and sworn to February 20th, 1891, throws still more light upon the subject of electric lights in that city and indicates that the statements that have been made by the superintendent of lighting were anything but reliable. The superintendent, in his report to the comptroller for the year ending Dec. 31, 18 0, says: "The present cost of operating 900 arc lights, at $83 each per year, is $74,700, or $2,280 in excess of the amount paid for the gas these displace." When we consider, that of the four stations furnishing these lights, District No. 1 only commenced operations December 24th, 1890; District No. 4 commenced February 22nd, 1890; District No. 6 commenced March 17th, 1890, and District No. 8 commenced operating May 26th, 1890, not one of them for a full year and No. 1 station only for seven days during the year, we are led to wonder, if the lights only cost 19 cents per night, why the superintendent should call upon the city to pay $83 per lamp and also for the full year.

An examination of the comptroller's report gives us still more suggestive figures. On page 76, it says, the "increase in the value of the electric light plants from January 1st, 1890, to January 1st, 1891, was $96,764.96," while on page 59 it is stated that the city "paid for electric light plant and maintenance of same, $229,569.42." Now, if as is shown on page 76, only $96,764.96 was used for increasing plant, the cost of running the lights was $132,804.46, being $147.56 per year for each lamp (running a full year) and this does not include interest, depreciation, taxes, water rent or insurance. As none of these lamps burned a full year (No. 8 station was in operation only seven months, and No. 1 station only seven days during the year), of course the cost to the city was more than this price per lamp. These figures are taken from the statement of finances of the city of Chicago and are sworn to; therefore we may rely upon their correctness.

The city has already expended $526,184.47 in electrical plants and apparatus for four stations, and the superintendent of lighting says the expenses to be incurred in 1891 for increasing these four stations will be $282,186; and on page 20 of report the comptroller says "the cost of the public lighting steadily increases." On the same page of this report the statement is made that claims for large damages have been filed against the city by property owners on account of the viaducts, and that "even under the most favorable results there will be large sums which the city will be obliged to pay sooner or later." It may be the superintendent meant the lights cost $19 per night instead of 19 cents; it certainly would have been about as near the truth.

Here is the practical result of a municipal plant, as shown by the official reports and records of the city. Still, in the list which is being circulated broadcast by the advocates of municipal ownership, we are told the electric lights in Chicago only cost the city $55.60 per lamp per year. *O Tempora! O Mores!*

NALDER'S BALLISTIC GALVANOMETER.

A good deal of inconvenience sometimes attends the use of the ordinary form of control magnet in a galvanometer. This arises from its being really required to perform two distinct functions; first, to alter the strength of the field acting on the needle system, and, secondly, its direction; the former determining the sensitiveness of the instrument and the latter the zero position of the needle. When altering the one it is difficult to avoid altering the other, and the inconvenience becomes the greater, the slower the swing. The form of control shown in the accompanying illustrations was suggested by Dr. R. Mullineux Walmsley, of the Heriot-Watt College, Edinburgh, who wished to more or less avoid this double effect of the magnet. The usual one is replaced by the much smaller one, A, Fig. 1, as fixed on the top of the case, and which can be turned round, but not raised or lowered. By it the spot is first brought to zero. The combined field of the earth and A are then diminished (or increased if a quick swing is required) by turning the tail magnet B on its shaft, or bringing it nearer or further off; but it will be observed that, from the symmetrical position of this magnet with respect to the needle system, when thus moved or turned, it merely alters the intensity of the field without interfering with its direction. Any slight shifting of zero which may occur, due to want of absolute symmetry, is adjusted by a very slight movement of A.

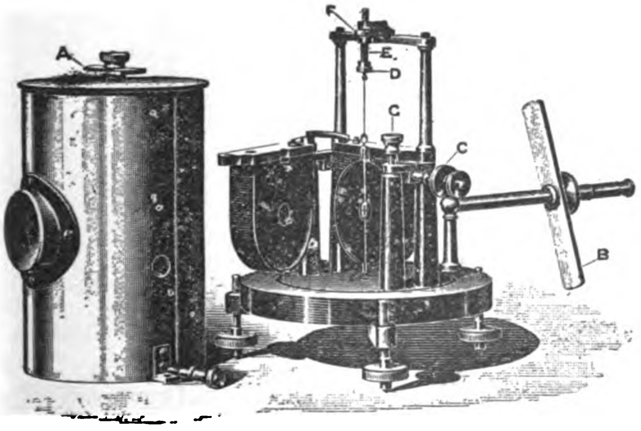


FIG. 1.—NALDER'S BALLISTIC GALVANOMETER.

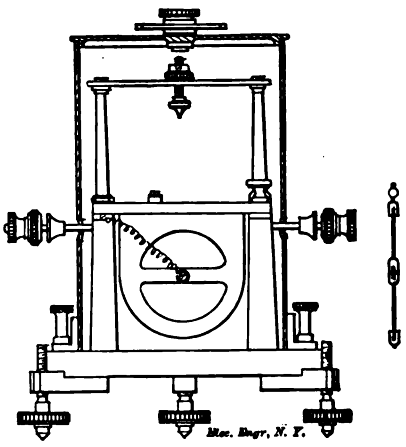


FIG. 2.—NALDER'S BALLISTIC GALVANOMETER.

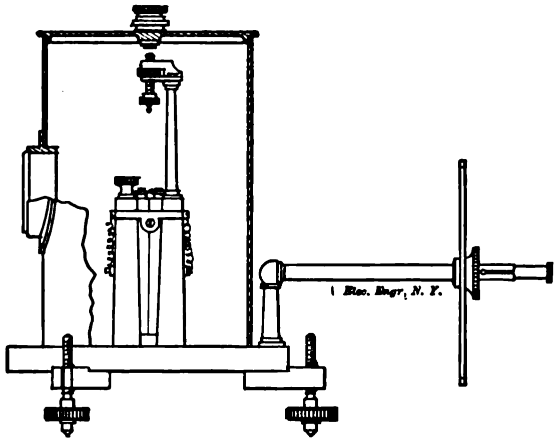


FIG. 3.—NALDER'S BALLISTIC GALVANOMETER.

Messrs. Nalder Brothers & Co., of London, have applied this method of control to ballistic galvanometers. There are one or two details about this pattern that may be noted. The whole cell is supported on ebonite pillars, and the terminals screw into plates in these after the cover is on, passing through holes in the latter, which are closed by sliding ebonite plugs, C, to keep the dust out when the instrument is not in use. The front coil is hinged so that the needle system is left clear in case a new fibre is required. The attachment for the fibre, D, is free to turn on the end of the rod, E, so that torsion can be taken out; D itself is threaded, and raised or lowered by the nut F, but has a longitudinal slot in it in which a pin works, so that the rod cannot turn round. The second connection to the front coil is through the clamping screw G, which holds the coil in place when closed. In Figs. 2 and 3, the instrument together with the needle system with its heavy bell-shaped magnets is shown in detail.

WHAT ARE THE LIMITS OF HIGH POTENTIAL TRANSMISSION?

BY

Chas. Steinmetz.

In the last number of The Electrical Engineer, I noticed Mr. A. Schneller's criticism of the project to transmit 300 h. p. by alternating currents of 30,000 volts pressure over a distance of 115 miles. As Mr. Schneller's rather unfavorable remark, "technical impossibility," might perhaps influence the opinion of many engineers against the advisability of power transmission under such pressures, I deem it proper to show the fallacy of Mr. Schneller's conclusions. Of course, everyone will acknowledge that the use of 30,000 volts pressure will bring about difficulties not met with in usual practice, and quite some experience will have to be gathered; and even partial failures are to be expected, before Niagara Falls water-power will light New York's streets, and drive the shafting in its factories.

But to come to Mr. Schneller's criticism, it is neither unsafe nor difficult to build reliable transformers for pressures of 30,000 volts and even more, because every large Ruhmkorff spark coil generates hundreds of thousands of volts. We must only bear in mind then, that for such pressures air-spaces can no longer be considered as insulators. Hence we have to enclose the whole transforming apparatus in a medium of better insulating qualities, as was done with the oil-transformers used in the Oerlikon experiments.

The leakage-current through the oil insulators of the line conductors, is considered even by Mr. Schneller as unimportant. I consider it of still less importance, because I hardly think that Mr. Brown had the best possible oil-insulators for his tests, and so I think that even the 3.2 per cent. loss referred to, will be essentially reduced.

Mr. Schneller considers the charging loss in the oil-insulators as the principle one, and calculates an enormous value for it, while the Oerlikon experiments, even when using a pressure higher than 30,000 volts, and a number of insulators equivalent to quite a considerable part of the proposed line between Frankfort and Lauffen, showed no perceptible charging loss No one, up to the present, in designing insulators, has paid any attention to their static capacity, for the very simple reason that this capacity has thus far been without importance. If condenser capacity of insulators should show any influence in practical working, it will be an easy task to build insulators with the least possible capacity, just as telephone cables are built for least possible capacity, this being essential for their effective working.

Then Mr. Schneller gives figures of charging losses without giving the number of periods per second employed; but the charging loss is directly proportional to the number of periods, and therefore by reducing the number to, say one-fourth, it would be decreased by 75 per cent. while generators and transformers of a size fitted for use in such large power transmissions will work just as economically as with higher frequencies, and motors even more economically.

Furthermore, with regard to the silent discharge which Mr. Schneller charged with a loss of 20,000 watts, everybody who ever handled a static electric machine, for instance a Töpler-Holtz, which gives pressures far in excess of 30,000 volts, knows that by simply covering the conductor with an insulator such as india rubber, the brush-discharge from the rubber covered parts disappears almost entirely.

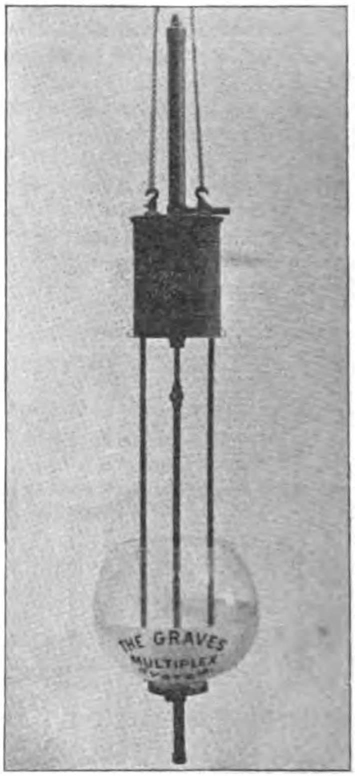
Therefore, these two large losses which to Mr. Schneller seem to prove the project a technical impossibility, can exist only in a line improperly built and poorly insulated; but by proper care in the construction, they can be made so small that they may very likely be entirely neglected.

One word more about the telephone disturbances. These disturbances are proportional to the current flowing in the line, and entirely independent of the pressure, so that a given current always gives the same disturbance, no matter whether it is backed only by a few volts or forced ahead by hundred thousands of volts. Therefore every increase of pressure will materially reduce the telephone disturbance by reducing the current needed to transmit the power.

Therefore I consider a power transmission by means of such a pressure not at all as impracticable, nor 30,000 volts as the highest pressure possible to use, but consider it only as the second step in that direction, the first of which was taken by Ferranti by sending 10,000 volts into his primary mains; and I do not believe in any limit of pressure possible with the alternating current, but, on the contrary, that in the not distant future we shall see power transmissions for long distance railways, etc., working under a pressure of even hundreds of thousands of volts and working safely and satisfactorily.

THE GRAVES ARC LAMP.

The Graves multiplex single carbon arc lamp shown in the accompanying illustration, is the invention of Mr. W. D. Graves, of Cleveland, O., who has made the subject of arc lamps a special study for the past nine years.



The Graves Multiplex Arc Lamp.

The lamp does not contain any clock work, dash pots, or springs, and when once adjusted to a certain quantity of current, never needs changing. The clutch has a long bearing upon the rod and is so made that, should the rod become slightly worn it readily adjusts itself and prevents slipping.

These lamps are at the present time working very successfully on 110, 220 and 500 volt circuits, and also on 6.5, 8, 9.6, 10 and 18 ampere constant current circuits.

Thus it is obvious that it can be made to suit any of the standard currents and to use 1, 2, 3, 4, or, in fact, any number of sets of carbons in succession; and in order to do this it is not necessary to add any complicated mechanism.

The designer has arranged the construction of this lamp to meet the convenience of both the trimmer and the repairer, making it possible for an ordinary workman to take it all apart, clean, assemble and adjust it in the shortest possible time.

The lamp, when constructed for constant current circuits is provided with two positive automatic cut-outs, one, which provides for the failure of the lamp to feed, and another, to protect the circuit when the carbons are entirely consumed. This latter cuts the lamp out through no resistance, thus saving the power required to maintain the current through the resistance of the other cut-out coils. It will thus be seen that it is practically impossible to burn out either of the coils, or any other part of the lamp.

When two or more sets of carbons are used, the action of the succeeding set does not depend upon the consumption of the former, for should the rod become hung or in any way prevented from feeding, a succeeding set is instantly thrown into circuit, and the other cut-out. The lamp presents a very neat appearance, is light in weight, having steel side rods of only sufficient strength to keep it in perfect allignment, and at the same time being so small that the shadow from them is brought to a minimum.

THE EFFECT OF INVENTION UPON THE PROGRESS OF ELECTRICAL SCIENCE.[1]

BY PROF. C. F. BRACKETT.

ELECTRICAL science really begins with the labors of Dr. Gilbert. These he published in 1600. For almost exactly two hundred years investigation was confined to that domain which is still sometimes called static electricity. A new era, however, dawned in 1800 when Volta gave to the world an invention whose importance can scarcely be exaggerated—the voltaic battery.

The simplicity of the device and the wonderful effects which it could produce at once excited the most lively interest, and men of science made haste to investigate it. By means of it Carlisle and Nicholson soon succeeded in decomposing water, and Ritter had a similar success with copper sulphate. Thus commenced a long line of research in electrolysis which was pursued with great success by Davy and others, and which finally led Faraday to the grand generalization known as Faraday's laws of electrolysis.

Meantime Ritter had noticed that the two plates of the same metal which have just served to convey the current to and from a liquid while undergoing electrolytic decomposition can, of themselves, furnish a current, and he was thus led to the invention of the "storage battery." It was Volta, however, who gave the correct explanation of its action.

Ritter, Pfaff, and others observed that the conducting wires of the battery are warmed by the passage of the current, and Curtet, on closing the circuit with a piece of charcoal, produced a brilliant light. Davy systematically investigated these heating effects of the current, employing various metals as conductors, and finally in 1812, on making the current pass between two pieces of charcoal he produced the well-known arc.

Thus, in little more than a decade from the date of Volta's invention, more real progress was made than in any century previous. But the true progress of electrical science is not to be measured solely, or even mainly, by the number nor by the splendor of the physical results which attend it, but rather by the insight into the operations of nature which we gain. Viewed in this light, Volta's invention was itself the embodiment of a great advance which he had made into an entirely new region. It was not the mere outcome of happy accident, but the result of severely logical reasoning upon facts which he had observed while he was investigating the so-called "animal electricity" of Galvani.

Volta's fundamental research respecting the electrical disturbances, produced by contact of dissimilar substances, afforded him a basis for a rational theory of the action of the battery, and this theory has had a far-reaching influence not only upon the progress of electrical science but on physical science in general.

The voltaic battery rendered possible an observation, out of which grew the next great invention which we will consider. In 1820 Oersted noticed that a magnetic needle was deflected from its normal position by voltaic current which was flowing in a conductor near it. He determined the relation of the current to the deflection as respects direction, and sent a brief memoir concerning the matter to well-known scientists.

Arago immediately found that iron filings were attracted by a wire conveying a voltaic current. In order to strengthen the magnetic action of the current, Schweigger invented the magnetizing helix or spiral. By means of this Arago was able to magnetize steel permanently and iron temporarily. The conception of this helix was the first act of invention which was to produce the electro-magnet. Yet, it was not until 1825 that Sturgeon wound a conducting wire about a core of iron to produce the electro-magnet proper. The magnet, as it left the hand of Sturgeon, was a crude device, which the genius of Henry finally perfected between the years 1828 and 1831. Henry constructed several magnets, some of which were wound with long, thin insulated wires, while others were wound with shorter and thicker wires in parallel. These could be joined either in series or in parallel. He thus had the means of studying the effects which a given battery can produce when made to actuate magnets having different windings. He also investigated the effects which are produced by the use of batteries having different electro-motive forces. He thus discovered the principles which must be observed in order to secure the best results from the electro-magnet under any given conditions. Indeed, a careful examination of Henry's work will convince one that he disclosed the same result by the light of skillful experiment, as is set forth in Ohm's now well-known formula. Moreover, he clearly perceived that the magnet, as he had perfected it, offered the solution of the problem of the telegraph, and he made proof of his prevision by actually installing one.

In the hands of Ampere the conducting helix was made, under one form or another, a means of investigation which he pushed with wonderful energy and skill until he unfolded the laws of interaction between magnets and electrical currents, as well as those which govern the mutual actions of the currents themselves. In short, it may be said that as the result of his inquiries, Ampere was brought to a comprehensive theory of magnetic action which was startling alike for its simplicity and its boldness. It deserves to rank with Newton's theory of universal attraction.

The skillful labors of Faraday and Henry brought to light by the same means, the laws of induced currents, and so supplied the elements which practical inventors have since combined so as to do our bidding, whether it be to illumine our streets and dwellings, push our cars, or delve in the mountain for hidden treasure.

The electro-magnetic phenomena educed by the voltaic current as it flows through a helix, constitutes the basis of a most admirable system of measurement for electrical quantities, while the helix itself contains, in germ, the whole family of measuring instruments, by means of which such measurements are made. Moreover, these phenomena led the sagacious mind of Faraday to a wholly new way of regarding electrical action in general. He clearly perceived that the old doctrine of the "imponderables" was untenable, and he looked for some common nexus between all physical actions. He was disposed to refer the interactions which bodies exhibit in consequence of their electrical states, to the medium intervening between them. As light is believed to be transmitted by a universal medium, he sought to find, by experiment, some connection between light and electro-magnetic action. On passing a beam of plane polarized light through a block of glass within a magnetizing helix, he found that the beam was twisted when the current was made to flow through the helix.

Maxwell undertook the very important work of subjecting the results reached by previous workers, and generally set forth in Faraday's "Experimental Researches" to mathematical discussion which must be considered the final test of truth. Not to mention others, one very important result was his "electro-magnetic theory of light." But experiments were wanting, save the single one of Faraday, just mentioned, to confirm his deduction. It was reserved for Hertz to supply the necessary evidence in support of Maxwell's theory, which he has lately done by making skillful use of the oscillating discharge of charged conductors, earlier demonstrated by Henry.

Thus it appears that the two great germinal inventions which have most influenced the progress of electrical science, during our century, are the voltaic battery and the magnetizing helix. The one gave us first the means of evoking electrical energy continuously, while the other gave us the means of applying it as we might have occasion. Both contributed powerfully in a direct way to the progress of electrical science, by reason of the various and startling phenomena which they revealed.

But it seldom happens that progress continues long in any department of physical science unaffected by the practical application of its results in the arts, and, conversely, such applications almost invariably react to stimulate scientific inquiry. Two principal reasons for this effect may be noticed. When the apparatus and the operations of the laboratory give place to those which are suited to commercial uses, new conditions arise which frequently bring into prominence phenomena before unobserved or inconspicuous. These then become subjects for new investigations and in due time scientific progress is the result. Thus telegraphy brought its knotty problems as well as its successes, especially when its lines were stretched under the sea and when one wire was required to do the duty of several, and nothing less than the highest skill and the most severe analysis has sufficed to effect their solution. So, too, telephony was early beset with peculiar difficulties, notwithstanding the simplicity of the means which it employs, thanks to the genius of Professor Bell; but they were such as electrical science has profited from. Speaking generally, it may be said that almost every one of the devices which are in daily use for the transformation of mechanical work into electrical energy, and the converse, has compelled its inventors, in the course of its evolution, to contribute something to the common stock of scientific truth.

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[1] A paper read at the Patent Centennial Celebration, Washington, April 8, 1891.

It was regretted by Franklin that the results of electrical research had not been turned more to the use of man in practical affairs. Faraday did not doubt that the time would come when that reproach would be removed, but he felt that it was a duty on his own part to push on the work of discovery, and to leave industrial inventions to others. Such applications are now everywhere about us and are rapidly extending. Of course they involve the investment of millions of capital, and this renders it impossible that the great public shall be indifferent to the science upon which they depend. Hence it is that all our schools of technology and most of our colleges have already made provision for training in it.

Every consideration leads us to expect that future progress in electrical science will be more rapid than it has ever been in the past; the present offers to the student the accumulated treasures of knowledge and the hope of scientific distinction as well as that of pecuniary reward. It can hardly be that among the scores of young men to whom these advantages come as inspirations, there will not be found some who shall prove to be worthy successors of the great men into whose labors they so easily enter.

A CENTURY OF PATENT LAWS.[1]

BY JUSTICE S. BLATCHFORD, U. S. SUP. COURT.

I have been requested by the committee which has charge of the ceremonies of this celebration of the beginning of the second century of the American patent system, to address you on the subject of "A Century of Patent Law."

As we derive the principles of our statutory and administrative patent law from England, it seems proper to regard the subject as covering English patent law, to a certain extent.

Prior to the English statute of 21 James I., chapter 3, passed in 1623, entitled "An act concerning monopolies and dispensations with penal laws and the forfeiture thereof," commonly called "the Statute of Monopolies," it was customary for the King, by virtue of his prerogative, to grant exclusive privileges or monopolies to individuals according to his pleasure, and not because of any invention or discovery which the individual had made, or had been the first to introduce into the kingdom. To such an extent was this carried, that Edward III. granted to two persons a patent of privilege for the sole making of "the Philosopher's Stone;" and, by subsequent sovereigns, patents were granted for the sole manufacture of playing cards, and for an exclusive right to sell various necessaries of life.

By the Statute of Monopolies, all monopolies were abolished as contrary to law, excepting grants to the first inventor of any manner of new manufacture, of the sole privilege of working or making the same. The statute did not bring such grants into existence, but excepted them out of the grants of monopolies, and left them to depend upon the common law for their legality.

James I. in 1610 had made a public declaration that all grants of monopolies and of the benefit of any penal laws, or of power to dispense with the law, or to compound for the forfeiture, were contrary to the laws of the kingdom, and had commanded that no suitor should presume to move the King for matters of that nature.

Section 1 of the Statute of Monopolies declared that all monopolies theretofore granted, or thereafter to be granted, for the sole making or using of anything, should be void. Section 6 of the act provided that the inhibition should not extend to a patent of privilege "of the sole working or making of any manner of new manufactures within this realm to the true and first inventor" thereof, which others at the time of making the grant "shall not use, so as also they be not contrary to the law, nor mischievous to the State, by raising prices of commodities at home, or hurt of trade, or generally inconvenient," their duration to be for 21 years from their date, in respect to patents theretofore granted for more than 21 years, and to be for 14 years or under in respect to patents thereafter to be granted.

For many years after the passing of this statute, the arts and manufactures continued in a low state in England, and few of the inventions patented were of any value. Until the reign of George III., the law reports are almost entirely silent respecting patent privileges; and almost the only case reported during that period is that of *Edgeberry and Stephens*, (2 *Salkeld*, 447,) where it was held, construing the statute of 21 James I., that "if the invention be new in England, a patent may be granted, though the thing was practiced beyond the sea before; for the statute speaks of new manufactures within this realm; so that if they be new here, it is within the statute, for the act intended to encourage new devices useful to the kingdom, and whether learned by travel or by study, it is the same thing."

Since that decision, it has been the uniform practice in England to grant letters patent to a person who introduces an invention not used before within the kingdom; and Parliament has repeatedly recognized the principle, by granting exclusive privileges to such introducers.

The first case of importance respecting a patent was an action of *scire facias* brought against Sir Richard Arkwright, (*The King* v. *Arkwright*, 1 *Webster*, 60,) to repeal his patent for an invention of a machine for preparing material for spinning, which action was tried in June, 1785.

About ten years afterwards, the important cases of *Boulton and Watt* v. *Bull*, (2 *Hen. Black.* 463,) and *Hornblower* v. *Boulton and Watt*, (8 *Term R.* 95,) in regard to the great invention of James Watt in steam engines, were tried, in which the patent law was much discussed, and many of its difficulties and obscurities were cleared away. In the second of the above cases, the patent granted to Watt in 1769 was held by the Court of King's Bench to be valid. Since that time the issue of patents for inventions has increased steadily, the interests involved in them have assumed immeasurable importance and magnitude, and the principles of law applicable to them have been developed and applied by judicial decisions of the highest value.

In 1765, the idea occurred to Watt that if the steam were to be condensed in a vessel distinct from the cylinder, it would be practicable to obtain a low temperature of condensation, and still keep up the temperature of the cylinder. For that purpose he provided a separate vessel into which the steam from the cylinder entered, which vessel was to be kept cold either by injecting cold water into it or by letting cold water fall over the outside of it, and so a vacuum could be maintained in the separate vessel. Thus the steam which passed over from the cylinder would be condensed, the pressure in the cylinder would be as low as the pressure in the condenser, and the temperature of the metal of the cylinder and piston would be kept up, since no cold injection water would come in contact with them. On putting the apparatus to a test, it operated as was expected; and, to maintain the vacuum in the separate condenser, Watt added an air-pump to remove the condensed steam and injection water, with any air that might gather in the condenser.

He added several subsidiary inventions, such as more tightly packing the piston, closing the upper end of the cylinder, enclosing the piston with a steam-tight stuffing box on top of the cylinder, causing steam instead of air to press on top of the piston, casing the cylinder in a non-conducting material; and introducing a steam-jacket between the cylinder and an outer shell. All these features were specified in his first patent, which was obtained in January, 1769.

By an act of Parliament passed in 1775, that patent was continued for 25 years, and Watt, in connection with Matthew Boulton, who owned some engineering works at Birmingham, entered upon the manufacture of steam engines. At first the only application of the engine was to pumping water from mines, but Watt soon made other inventions to fit the engine for other uses, and took out further patents in 1781, 1782 and 1784. These inventions covered the method of converting the reciprocating motion of the piston into a rotary motion, so that ordinary machinery could be driven, making the engine double-acting by putting both ends of the cylinder in communication alternately, with the boiler and the condenser, instead of only one end, introducing the system of the expansive working of the steam, instead of admitting it through the whole stroke of the piston; and the well-known parallel motion.

Watt's principal patent was sustained by the courts of England, and he enjoyed the fruits of it until it expired in the year 1800. To his great invention we owe the development of the steam engine as used now for traffic and transportation by water and land; for, without it, there could be no practical or efficient steam engine.

The statutes which now regulate the granting of patents in England are those of August 25, 1883, (46 and 47 *Vict. ch.* 57,) and December 24, 1888, (51 and 52 *Vict. ch.* 50.) It is not necessary that a person should be a British subject to apply for a patent. The application must state that the applicant is in possession of an invention of which he claims to be the true and first inventor. The word "inventor" in these statutes covers an introducer. It is declared by the act of 1883 that the word "inventor" means

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[1] Abstract of address delivered at the Patent Centennial Celebration, Washington, April 8, 1891.

"any manner of new manufacture, the subject of letters-patent and grant of privilege," within section 6 of the act of 21 James I., chapter 3, and includes an alleged invention. There must be either a provisional or a complete specification. If there is only a provisional specification, there must be a complete specification within nine months after the application. There is a limited examination which extends only to an inquiry whether the nature of the invention has been fairly described, and whether the application, specification, and drawings, if any, are in due form, and whether the title sufficiently indicates the subject-matter of the invention. The acceptance of the complete specification is to be advertised, and any person may, within two months thereafter, give notice at the Patent Office that he opposes the grant of the patent on the ground that the applicant obtained the invention from him or from a person of whom he is the legal representative, or on the ground that the invention was patented in England on an application of prior date, or on the ground that the complete specification describes or claims an invention other than that described in the provisional specification, and that such other invention forms the subject of an application made by the opponent in the interval between the making of the two specifications. The patent is to be granted for 14 years, but is to cease if certain fees are not paid within specified times. Disclaimers and amendments of specifications are provided for, but no amendment is allowable which would make the specification, as amended, claim an invention substantially larger than, or substantially different from the invention claimed by the specification as it stood before amendment. At least six months before the time limited for the expiration of the patent, the patentee may apply for an extension, which may be granted on a favorable report from the judicial committee of the Privy Council, for a further term not exceeding 7, or, in exceptional cases, 14 years, and a patent may be vacated by a court on certain specified grounds.

Let us pass now to the patent statutes of the United States.

The Constitution, in article 1, section 8, declares that the Congress shall have power to promote the progress of science and useful arts by securing, for limited times, to inventors the exclusive right to their discoveries.

The first act of Congress on the subject was that of April 10, 1790, entitled "An act to promote the progress of useful arts." This provided for the granting of a patent to the inventor or discoverer of any "useful art, manufacture, engine, machine or device, or any improvement therein, not before known or used." A written specification with drawings, and, if admissable, a model, was required. No examination as to the novelty of the invention was provided for. On an application made to a judge of a District Court within one year after the grant of a patent, if it was obtained surreptitiously or upon false suggestion, or if it should appear that the patentee was not the first or true inventor or discoverer, the judge might repeal the patent.

Further acts in regard to patents were passed in 1793, 1794, 1800 and 1832.

On July 4, 1836, an act was passed reorganizing the patent system and repealing all prior acts. By that act patents were to be granted for fourteen years, with the privilege of an extension by the Commissioner, in a proper case, for seven years more. It was required that the applicant should have discovered or invented a new and useful art, machine, manufacture, or composition of matter, or a new and useful improvement thereon, not known or used by others before his discovery or invention, and not, at the time of the application, in public use or on sale, with his consent or allowance, as the inventor or discoverer. He was required to deliver a written description of his invention or discovery, and of the manner and process of making, constructing, using, and compounding the same, in such full, clear, and exact terms, avoiding unnecessary prolixity, as to enable any person skilled in the art or science to which it appertained, or with which it was most nearly connected, to make, construct, compound, and use the same; and in case of a machine, to explain fully the principle and the several modes in which he had contemplated the application of that principle or character by which it might be distinguished from other inventions; and particularly to specify and point out the part, improvement, or combination, which he claimed as his own invention or discovery. Drawings were provided for, and specimens of ingredients of a composition of matter, and a model of machinery, where admissable. A system of examination was instituted, and the patent was to issue if it should not appear to the Commissioner that the alleged invention or discovery had been invented or discovered by any other person in this country, prior to the alleged invention or discovery by the applicant, or that it had been patented, or described in any printed publication, in this or any foreign country, or had been in public use or on sale with the applicant's consent or allowance, prior to the application, and if the Commissioner should deem it to be sufficiently useful and important. On the refusal of a patent, an appeal was provided for to a board of three examiners. An interference with another pending application, or with an unexpired patent, could be declared, with an appeal to a like board. In case a patent should be inoperative or invalid, by reason of a defective or insufficient description or specification, or by reason of the patentee claiming in the specification as his own invention more than he should have a right to claim as new, if the error arose by inadvertency, accident, or mistake, and without any fraudulent or deceptive intention, the Commissioner, on the surrender of the patent, could cause a new patent to be issued to the inventor for the same invention, for the residue of the period then unexpired for which the original patent was granted, in accordance with the patentee's corrected description and specification. This was called "a reissue," Provision was made for special defences in actions for damages for infringement, and for giving to the plantiff thirty days' notice before the trial, of the defense of prior use; also for a remedy by bill in equity in the case of two interfering patents, or of the refusal to grant a patent on the ground of its interference with a previous unexpired patent. Equity jurisdiction by the Circuit Courts of the United States was created. with the power of granting injunctions against infringement. An extension of a patent for seven years was provided for, on its appearing that the patentee, without neglect or fault on his part, has failed to obtain reasonable remuneration,

The foregoing features of the patent system were substantially re-enacted in the act of July 8, 1870, the provisions of which are embodied in the Revised Statutes; but by statute a patent is now granted for only 17 years, and no provision is made for an extension.

In the administration of the patent laws by the courts of the United States, the proper rights of inventors have been firmly maintained, while the abuses which crept in, in consequence of improper reissues of patents, have been corrected. Patents for important and meritorious inventions have been sustained, notably in the case of Morse's telegraph, which was held valid in the case of *O'Reilly* v. *Morse* (15 *Howard*, 62,) the opinion being delivered by Chief Justice Taney.

Samuel F. B. Morse was a historical painter, and had gone to Europe in 1829 to perfect himself in his art. In October, 1832, on board the packet-ship "Sully," on her passage from Havre, in France, to New York, he conceived the invention which he afterward patented. He persevered in his invention, and by the forepart of the year 1836 he had constructed an instrument which marked down intelligibly telegraphic signs, and demonstrated by actual operation its capacity to accomplish his purpose. Further experiments were made, and in the latter part of September, 1837, a caveat was drawn up and in the following month was filed in the Patent Office. In February, 1838, a new instrument was exhibited by Professor Morse in the Franklin Institute, at Philadelphia, where it operated with success through a circuit of ten miles of wire; and a committee of the Institute made a report of its success. It was then removed to the city of Washington, and publicly exhibited in the hall of the House of Representatives. On the 3d of March, 1843, Congress appropriated $30,000 to test the capacity and usefulness of the telegraph, by constructing a line under the superintendence of Professor Morse, between the cities of Washington and Baltimore, which was done in the year 1844. The United States patent having been granted to him on June 20, 1840, it was reissued in January, 1846, and came before the Supreme Court of the United States at its December term, 1853. It was sustained after a vigorous opposition.

The principle on which the patent laws are based is to give an inventor an exclusive right, for a limited time, in consideration of his fully disclosing his invention, so that it may be made and used by the public after the limited term shall have expired. Under this stimulus there has come into existence the brilliant succession of inventions which have contributed so greatly to the progress of the science and the arts, and to the material welfare of nations and individuals. In this career our own country has played no small part, and it is quite certain that in the future American inventors will do their full share toward illustrating the beneficent operation of the patent laws, and that when, a hundred years hence, there shall be another centennial celebralike the one through which we are now passing. there will have occurred no diminution of the importance and value of American inventions.

AN ITALIAN ELEVATED ELECTRIC RAILWAY.

The highest elevated railroad in the world is about to be built in Naples. It is intended to connect the central part of Naples with the Corso Vittorio Emanuele. It is designed by civil engineer Adolfo Aveno, and the estimated expense will be about $1,000,000. The road will be suspended from towers 100 metres high, in which will be elevators to carry passengers to the station. The road will be operated by electricity, generated by the force of the waterfall of the river Serreno.

MR. H. R. LEYDEN has resigned his position with the United Electric Light and Power Co., of this city, to take charge of the drafting, and estimating with Mr. Dugald C. Jackson, district engineer of the Edison General Electric Co., at Chicago.

THE
ELECTRICAL ENGINEER.
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VOL. XI. NEW YORK, APRIL 15, 1891. No. 154.

In science, as in religion, we see as through a glass darkly, and we must not attach too much importance to forms of thought, which, like all things human, are subject to limitations and liable to change.—Josiah Parsons Cooke.

THE PATENT CENTENNIAL CELEBRATION.

THE celebration last week in Washington of the granting of the first American patent 100 years ago, and of the beginning of the second century of the American patent system, proved of much interest. To a certain extent it has seemed as though the celebration lacked spontaneity on the part of those who joined in it and suffered for the lack of some definite purpose, but, on the whole, such an event must be productive of good, and as our report of the proceedings and papers shows not a few wise and sensible things were said, while the resolve to be practical was manifested in the organization of the national association of patentees.

The patent system of this country, based on a mere score of words in the Constitution, has certainly been worthy of the praise bestowed upon it, and while there are some things that might be bettered, it is to be hoped that in the main the system will stand as it is another hundred years. The trouble in a country like this, where we start out with conditions and institutions about as nearly right as they ought to be, is to keep in check the hankering after change and novelty that is a big part of human nature, and to which, in fact, the American pre-eminence in invention is largely due. However, there is no very burning desire in any quarter to make radical changes in the system, and we trust, therefore, that it will be allowed to go on doing its great work. But in order that this work may be most successfully performed, a number of minor improvements are unquestionably needed. A new Patent Office building is wanted, or else the old building must be devoted to its original and legitimate purpose. The force in the Patent Office should be better paid, and the men there should be given inducements to stay after they have become valuable. The arrears of work should be brought up. At this minute over 7,000 applications await attention. In some departments of electricity, the applications are two and three months behind, and yet in these times of active electrical development, a month counts like a century.

Now it cannot be said that such reforms will cost the nation anything. The excess last year of Patent Office income over expenditure was $200,000, and the total surplus is about $4,000,000. Now this money should be spent in such ways as here suggested for the benefit of the inventor, or else the tax on invention in the shape of fees proved to be unnecessarily high should be mitigated. So far from costing the country anything, any liberal and just measure of this kind will return tenfold on the outlay required for making it.

PROF. THOMSON'S NEW ALTERNATOR.

THE discussion which has been carried on in our columns recently on the phenomena connected with alternating currents of high frequency, has naturally drawn attention to the machines by which these high frequencies are produced. We have already described the machine designed by Mr. Tesla for that purpose, and have drawn attention to the general design adopted by Prof. Elihu Thomson. In this issue we are enabled to present the Thomson machine as it has been actually constructed, with some of the detailed information regarding its performance. The results there given show the machine to be one of very efficient design, and though only tested over a small range of loads, the indications are that even at its maximum capacity the machine will prove of high efficiency. The mechanical construction has also a number of advantages, not the least among which is the fact that all wire employed on the machine is stationary, the multipolar magnet alone being kept in motion.

THE TELEPHONIC DISASTERS AT ALBANY.

WE presume that the entire electrical fraternity is familiar with the terrible and frequent disasters that the Albany Exchange of the Hudson River Telephone Co. has recently met with, and that every one has felt the greatest sympathy with Mr. A. B. Uline, the manager, in his troubles. It is more than serious to have an exchange service practically wiped out four times by storm and fire in four months, and the occurrences have elicited no end of discussion, as well as no little alarm, among telephone subscribers. Very naturally the telephone people hold the electric railway trolley wire responsible for most of their trouble in this matter, and we understand that they now anticipate frequent repetitions so long as the city permits the railway to use its trolley wires without guard wires overhead.

This brings up a very important question, as the benefits of "guard wires" are not indisputable. We have therefore asked Mr. W. H. Cull of Albany, to give us his views on this subject, as one peculiarly qualified to express an opinion of value. Mr. Cull, while superintendent and electrician of the Albany railway to-day, which he has made one of the "show roads" of the new industry, was also for seven years superintendent and electrician of the Hudson River Telephone Co. Hence he is better informed, perhaps, than any other man in the country as to the difficulties and objections on each side. In reply to our inquiries, Mr. Cull says :—

> "The expense of putting up these guard wires ought to be a matter of very little importance to a railway company, for a perfect guard wire would prove as great a blessing to them as to telephone and telegraph companies. The present imperfect guard, or protecting wire, I consider of very little avail for protecting either foreign wires, or the trolley wire ; they are so frequently 'alive,' that it almost makes a farce of the purpose they are intended for. It is said, a conductor on one of the electric cars in Boston noticed that the trolley wheel was arcing very badly ; upon examination he discovered that the car had been running some yards with the trolley wheel on the guard wire. An inspection of the line was made and it was found that a 'dead' telegraph line had fallen across the guard wire, and one of the span or suspension wires, which was imperfectly insulated from the trolley wire ; enough electricity escaped through this contact to propel a car ; this is one of the many ways that guard wires become 'alive,' and in many cases the cause of much damage."

Here is evidently a point well worth consideration. A precaution, which like some of the alleged "lightning protectors" is simply an added danger, cannot be too soon exposed. Mr. Cull adds, however : "I do not wish to be understood as being opposed to guard wires, on the contrary, I say, by all means put them up, and keep them as "dead" as if they were "buried," if it is possible to do so. The writer is familiar enough with the Telephone Exchange system to know that a wire carrying a high potential current, coming in contact with a telephone wire, is, to say the least, a decided nuisance, and the cause of much unparliamentary language from telephone managers. Quite frequently these crosses do not make themselves manifest until considerable damage has been done. It is these "sneak" currents that are most to be dreaded ; then too, many times, linemen cannot find where these crosses have occurred, as was the case in Albany last Monday." The telephone people charged that a telephone wire, ending about two miles out of the city, was crossed with the Albany Railway's trolley wire, but a thorough search and examination by both the telephone and railway company's linemen failed to elicit any evidence whatever of this wire having been crossed with the trolley wire.

Of course, with the placing of telephone wires underground, the liability to these disasters becomes much less. With the adoption of arresters that will arrest, the danger will also be minimized. But a large majority of the wires will remain overhead, and the telephone people do not seem to have been very well satisfied with the protectors they have tried. Under these circumstances, and as to meeting the situation, Mr. Cull says :—

> "It is hard to suggest a remedy to prevent the damage caused by reason of these frequent crosses. My own idea would be, to have two, or three linemen or inspectors, whose duties it would be to report to the manager of an exchange on all stormy days or nights, and to be stationed at the distributing board, cupola and switchboard, to keep a constant lookout for heavy current crosses ; and another man whose duties it would be to daily examine the fuse board and see that every wire running in the office had a suitable fuse connected therein. In fact, establish a sort of "fire patrol." A two or four volt, one-sixth ampere incandescent lamp introduced in each circuit at the distributing board would disclose the presence of any current sufficiently strong to damage the switchboard drop. In most cases they would open the line. This, however, would be quite expensive."

The overhead system is here to stay, having, not less than the telephone, proved its right to existence as an enormous and incalculable boon to the public. But it must be apparent that in view of the conditions dealt with above, the electric railway conduit becomes also an improvement at once highly necessary and important and the storage system remains as inviting a solution as ever of the problem.

THE BELL TELEPHONE COMPANY AND THE MICROPHONE INTERFERENCE.

The letter of Mr. W. C. Barney, on the Commercial Future of the Telephone, printed elsewhere in this issue, puts in a clear light an important feature of the patent situation, one which has occasionally been touched upon by the daily press, notably by the *N. Y. Times*, and which was brought into prominence during the investigation of the telephone companies by the New York legislature several years ago. There seems little doubt that in the existing state of the art a broad microphone patent would be the one strongest hold for the American Bell Telephone Company after the expiration of the Bell patent.

Although that company may be within its legal right in refraining from bringing the Berliner-Edison interference to a determination, and thus deferring indefinitely the issue of a microphone patent good for seventeen years ; we believe that this policy—and such appears to be its policy—involves a substantial grievance and an injustice to the public, and that its probable result—adding ten or twelve years to the effectual life of a patent—is abhorrent to the spirit and intention of our patent law.

We have regarded the attacks in the public press upon the general policy of the American Bell Telephone Company as, for the most part, ill-founded, immoderate and unfair, prompted by little knowledge and less sincerity ; but the indefinite suspension of the microphone case, unless the Bell Company can show satisfactory reason for it other than its obvious pecuniary interest will do much to augment and justify public dissatisfaction and complaint. The question is much broader than its bearing upon the single case referred to.

A Useful Index.

With this issue of The Electrical Engineer will be found a very thorough and complete index to the contents of Vol. X. There are various features that will recommend it for use, especially the system of explanatory notation and of elaborate cross reference, by which the nature of the article and its contents can be determined at once. The supplementary index of authors will also be found extremely useful, as one often remembers an article more by the writer and what he says than by the mere title.

THE HIGHEST ECONOMY IN THE USE OF INCANDESCENT LAMPS.

BY

H Ward Leonard

IN operating incandescent lamps of any particular make, their average life will depend upon the incandescence at which they are operated. The higher the incandescence of the carbon filament, the greater the amount of light which will be produced by the expenditure of a certain amount of energy, and the less the average life. *Lamps can be made by any manufacturer which shall have practically any desired average life, if the efficiency be not fixed.* As we decrease the power necessary, that is, increase the efficiency, we effect a saving in the first investment and in the cost of power required to operate the lamps, but simultaneously we decrease the average life of the lamps, and hence increase the cost in operating due to lamp renewals.

It will, therefore, be evident that whenever the cost of power and the cost of incandescent lamps for renewals is fixed, there will be a certain definite efficiency and corresponding life, which for any particular make of lamp will represent the condition of highest economy in the use of the lamps. The consumer of incandescent lamps has forcibly brought to his attention the cost of the lamps he uses for renewals, but is usually unable to determine definitely the amount and value of the power required to operate the lamps. Consequently, he is frequently led to believe that the *cheapest* lamp for him to use is necessarily that which gives the *longest life.* Unless the power required is the same for the different lamps, this is not true, and frequently consumers are operating at very poor economy, and yet believe they are obtaining very good results, merely because their lamp breakage is small.

Let us examine this subject briefly. The measurement of light is rated in "candle power," and the efficiency of production of the light is rated in "watts per candle." The number of watts required by any lamp is the product of the volts and amperes used by the lamp. Thus a 100 volt lamp using ½ an ampere absorbs 50 watts, and if the lamp be a 16 c. p. lamp, the "watts per candle," which is the measure of its efficiency, would be $\frac{50}{16} = 3.1$ watts per candle. Similarly, a lamp of 24 c. p. taking 110 volts and .676 ampere absorbs 75 watts, and has an efficiency as before, of $\frac{75}{24} = 3.1$ watts per candle. These two lamps, operated as indicated above, will have the same average life, because the incandescence of the carbon, and therefore the efficiency, is the same in the two instances. Let us suppose this average life to be 600 hours with the efficiency mentioned, namely, 3.1 watts per candle.

Now, suppose we take the lamp designed to be operated at 3.1 watts per candle, giving 24 c. p. at 110 volts, and instead of subjecting it to 110 volts, reduce the pressure to 104 volts. The reduction of pressure will cause a reduction in the current through the lamp from .676 ampere to .623 ampere; consequently, the watts absorbed by the filament will be 104 x .623 = 65 watts. The candle-power will be found to be 16 instead of 24 as formerly. The efficiency will be $\frac{65}{16} = 4.+$ watts per candle. The *average life* at this efficiency will be not less than 1,500 *hours.* Yet it *does not follow* that the *most economical results* will be obtained by operating the lamps at *such an efficiency and life,* although at first such might be thought to be the case.

In order to investigate this question, it becomes necessary to determine the cost of power under different conditions. Perhaps the best authority on this subject is Charles E. Emery, Ph. D., who has thoroughly investigated and reported upon this question. The following values are taken from his report:

The cost of producing 1 h. p. for 10 hours per day for 309 days in the year, by means of a first-class engine using 27 pounds of feed water per indicated horse-power per hour, is $52.15, where anthracite coal is $4.17 per ton, and where an engineer's wages are $2.00 per day. Of this $52.15, $24.06 is the cost of the coal, and $28.09 is that due to expenses outside of coal, such as wages, repairs, oil, waste, insurance, taxes, &c. That is, it costs $52.15 to produce 309 x 10 = 3,090 h. p. hours, hence 1 h. p. hour costs $\frac{52.15}{3,090} = 1.7$ cents.

The cost of the power for operating a 16 c. p. incandescent lamp will, of course, vary with the number operated per horse-power. When the lamps have an efficiency of 3.1 watts per candle, twelve 16 c. p. lamps are operated for each horse-power in the driving belt of the dynamo.

When the lamps have an efficiency of 3.6 watts per candle, 10-sixteen candle power lamps are operated per horse power; with lamps of 4 watts per candle, 9-sixteen candle power lamps are similarly operated per horse power, and with 2.77 watts per candle 18.4-sixteen candle power lamps. Consequently the cost of the power will be as shown in Table I. for operating one 16 candle power lamp for one hour:

TABLE I.

	For lamps of 2.77 watts per candle, *i. e.*, 18.4 lamps to H. P.	For lamps of 3.1 watts per candle, *i. e.*, 12 to H. P.	For lamps of 3.6 watts per candle, *i. e.*, 10 to H. P.	For lamps of 4 watts per candle, *i. e.*, 9 to H. P.
Cost of power per 16 c. p. lamp hour, with power at 1.7 cents per horse power hour.....	0.129 cts.	0.14 cts.	0.17 cts.	0.19 cts.

If the average life of the lamps of 3.1 watts be 600 hours, that of the 3.6 watts lamp will be about 900 hours, that of the 4 watts lamp 1,500 hours, and that of the 2.77 watts lamp 300 hours.

Let us assume that the initial cost of a 16 candle power lamp is 44 cents, then the cost of renewals per lamp hour would be as shown in Table II.

TABLE II.

	For lamps of 2.77 watts per candle, *i. e.*, 18.4 16 c. p. lamps to H. P. and 300 hours average life.	For lamps of 3.1 watts per candle, *i. e.*, 12 to H. P. and 600 hour life.	For lamps of 3.6 watts per candle, *i. e.*, 10 to H. P. and 900 hour life.	For lamps of 4 watts per candle, *i. e.*, 9 to H. P. and 1,500 hour life.
Cost of lamp renewals per 16 c. p. lamp hour, with lamps at 44 cents each.	0.146 cts.	0.073 cts.	0.049 cts.	0.029 cts.

Hence, the combined cost of both power and lamp renewals would be as shown in Table III.

TABLE III.

	For 16 c. p. lamps of 2.77 watts per candle and 300 hours average life.	For 16 c. p. lamps of 3.1 watts per candle and 600 hours average life.	For 16 c. p. lamps of 3.6 watts per candle and 900 hours average life.	For 16 c. p. lamps of 4 watts per candle and 1,500 hours average life.
Power..................	.129 cts.	.140 cts.	.170 cts.	.190 cts.
Lamp Renewals	.146 cts.	.073 cts.	.049 cts.	.029 cts.
Total cost per 16 c. p. lamp hour when power costs 1.7 cents per horse power hour and incandescent lamps cost 44 cents each..............	0.275 cts.	0.218 cts.	0.219 cts.	0.219 cts.

Thus, under the conditions given, the *most economical lamps* to use will be those of 3.1 *watts* per candle and 600 *hours* average life.

Now, let us suppose that the cost of power varies, as it will in different locations and under different conditions. It will be noted that of the $52.15 per year for the production of one horse power, $28.09, or 54 per cent., is independent of the cost of fuel. Let us suppose that the cost of fuel is nothing, and that the only expense in the production of power are those due to labor, repairs, insurance, taxes, etc., Table IV.

TABLE IV.

	For 16 c. p. lamps of 2.77 watts per candle and 300 hours average life.	For 16 c. p. lamps of 3.1 watts per candle and 600 hours average life.	For 16 c. p. lamps of 3.6 watts per candle and 900 hours average life.	For 16 c. p. lamps of 4 watts per candle and 1,500 hours average life.
Power...............	0.0684 c.	0.0742 c.	0.0901 c.	0.1007 c.
Lamp Renewals.......	0.1460 c.	0.0730 c.	0.0490 c.	0.0290 c.
Total cost per 16 c. p. lamp hour when fuel costs nothing and incandescent lamps cost 44 cents each.	0.2144 cts.	0.1472 cts.	0.1391 cts.	0.1297 cts.

It will be seen that the four watt lamp of 1,500 hours average life becomes the most economical to operate under such conditions.

Now, suppose the price of anthracite coal, or its equivalent, to be $2.00 per ton. We then have the following relations, Table V.

TABLE V.

	For 16 c. p. lamps of 2.77 watts per candle and 300 hours average life.	For 16 c. p. lamps of 3.1 watts per candle and 600 hours average life.	For 16 c. p. lamps of 3.6 watts per candle and average 900 hours life.	For 16 c. p. lamps of 4 watts per candle and average 1,500 hours life.
Power..................	0.0991 c.	0.108 cts.	0.089 cts.	0.146 cts.
Lamp Renewals.......	0.146 cts.	0.073 cts.	0.649 cts.	0.029 cts.
Total cost per 16 c. p. lamp hour where anthracite coal, or its equivalent, costs $2 per ton, and 16 c. p. lamps cost 44 cents each...	0.245 cts.	0.181 cts.	0.178 cts.	0.175 cts.

From the above figures it will be seen that the four watt lamp is the cheapest to operate under the conditions given, but the advantage is so trifling that in practice the 3.1 watt lamp would be the best to use, since the lamps fall off in candle power somewhat in long use, and with lamps having an average life of 600 hours, the average condition of the total number of lamps on a plant would be that due to 300 hours of burning, whereas the average condition of lamps having an average life of 1,500 hours would be that due to 750 hours' use, and it is evident that it will be preferable to have lamps which have averaged 300 hours of use, rather than lamps which have averaged 750 hours of use.

It will be seen by the figures given that the *life alone is a poor measure of the economy of an incandescent lamp*, and that in order that a four watt lamp should equal in quality a 3.1 watt lamp, its life should be 2½ times as long, and that its average candle power in burning its 1,500 hours should equal the average candle power of the 3.1 watts lamp in burning its 600 hours.

In all instances quoted thus far we have assumed a cost of power based upon its production for ten hours per day under extremely favorable conditions. In the case of incandescent lighting plants, the load changes widely, and the maximum load is on for only two or three hours. The production of power is much more expensive under such conditions than when the load is constant. Statistics from a very large number of central station incandescent lighting plants, charging an average rate of 1 cent per 16 candle lamp hour, show that the total cost of power for operating a 16 c. p. 3.1 watt lamp is 0.4 cent per hour. *The relative economy in the use of lamps of different efficiencies under average conditions of central station practice is, therefore, shown by the following Table* VI:

TABLE VI.

	For 16 c. p. lamps of 2.77 watts per candle and 300 hours average life.	For 16 c. p. lamps of 3.1 watts per candle and 600 hours average life.	For 16 c. p. lamps of 3.6 watts per candle and 900 hours average life.	For 16 c. p. lamps of 4 watts per candle and 1,500 hours average life.
Power...................	0.357 cts.	0.400 cts.	0.464 cts.	0.516 cts.
Lamp Renewals.......	0.146 cts.	0.073 cts.	0.049 cts.	0.029 cts.
Total cost per 16 candle lamp hour when the power to run a 16 c. p. 3.1 watt lamp costs 0.4 cents per hour, and lamps cost 44 cents each...................	0.503 cts.	0.473 cts.	0.513 cts.	0.545 cts.

It will be noticed that the operating expenses are 8 *per cent. less in the case of a plant using* 3.1 *watt* 600 *hour lamps than in the case of a plant using* 3.6 *watt* 900 *hour lamps. This is equivalent to an increase in the net profits of* 12 *per cent. in the case of an incandescent electric lighting company* whose expenses are 60 per cent. of the total receipts, which is an average relation between the expenses and receipts in properly operated stations.

Attention is called to the fact that if the life of the incandescent lamp be increased, or the price of the lamp be reduced, the importance of using the high efficiency lamp rather than the low efficiency lamp becomes even more marked than in the present instance. Thus, if the average life of a 16 c. p. lamp of 3.1 watts be 1,200 hours, and the cost of the lamp be 40 cents, it will be found that higher economy will result by operating the lamp at 2.77 watts per candle which will reduce the life to 600 hours. This is shown by the following table:

	For 16 c. p. lamp of 2.77 watts per candle and 600 hours average life.	For 16 c. p. lamp of 3.1 watts per candle and 1,200 hours life.
Power.......................................	0.357 cts.	0.400 cts.
Lamp Renewals...........	0.066 cts.	0.033 cts.
Total cost per 16 c. p. lamp hour when power for 3.1 watt lamp costs 0.4 cent per hour, and lamps cost 40 cents each...	0.423 cts.	0.433 cts.

In all systems having a fairly good regulation and distribution of pressure, and where coal costs from $2 upward for the equivalent of one ton of anthracite coal, the 3.1 watt lamp is the most economical.

In alternating systems as ordinarily installed, the variation of pressure is often too great to use the 3.1 watt lamp economically, and the 3.6 watt lamp should be used. Also in cases when the cost of power is extremely low, the 3.6 watt lamp should be used. It will not be found economical to operate the best makes of lamps at more than 3.6 watts per candle under any conditions met with in practice.

The majority of 16 *c. p. incandescent lamps on the market today require from* 57 *to* 65 *watts*, that is, to have an efficiency of from 3.6 to 4 watts; and attention is called to the fact that *in order to compare in quality with a lamp of* 50 *watts* with a guaranteed average life of 600 *hours* there should be a guarantee of 900 *hours* average life for the 57 *watt lamps*, and of 1,500 *hours* average life for the 65 *watt lamps*, and that *even then the consumer will not be operating at the highest economy* as shown above. Furthermore, it must be borne in mind that *by the use of* 3.1 *watt lamps*, the *capacity* of a plant already using 3.6 watt lamps, will be *increased* 16 *per cent.*, and in the case of a plant using 4 watt lamps, the *capacity* will be *increased* 30 *per cent.*

To express this another way, it may be said that a *consumer* having a plant *using* lamps of 3.1 *watts*, and *changing* to lamps of 4 *watts*, not only suffers the disadvantage due to the fact that he is *not operating* at the *highest economy*, but he also immediately *increases* his investment, interest, depreciation, &c., per unit of light obtained, to the extent of 30 *per cent.* and subjects his *dynamo* to an *overload* of 30 *per cent.*, with consequent greatly increased trouble and expense *due entirely to the use of the low economy lamps*, but frequently attributed to a defect in the dynamo as it is there that the overload manifests itself.

MR. E. A. SMITH has been appointed manager of the Meriden, Conn., telephone office.

NOTE ON THE RELATIVE DEGREE OF DISTURBANCE CAUSED BY ELECTROSTATIC AND ELECTROMAGNETIC INDUCTION BETWEEN CERTAIN SIMPLE ARRANGEMENTS OF TELEPHONE CIRCUITS.[1]

BY A. E. KENNELLY.

REFERRING to Fig. 2 of Mr. Carty's paper,[2] let L_1 be a primary line, L_2 and L_3 the lines of a secondary circuit. Suppose also, to simplify the conditions, that L_3 is so far remote from L_1 and L_2 by comparison with the half inch of distance separating these latter, that all inductive influence on or from L_3 may be omitted from consideration. The most convenient way of dealing with L_3, is to replace it by the ground, and we have then only to consider the two circuits L_1 and L_2 each taken as negligibly small for the case under discussion.

By considering first the amount of disturbance that would be statically set up in L_2 if electromagnetic action did not exist; and second the magnetic disturbance on the hypothesis that no static induction took place, it is possible to form a comparative estimate of the relative proportions of these disturbances, when, as in practice, both influences act together. The result will not be accurate, because the influence of each not only combines with, but also to a certain extent modifies, the action of the other; but the discrepancy due to so elementary a treatment will not in all probability invalidate the results as a first approximation.

Let k be the mutual electrostatic capacity of L_1 and L_2 per centimetre length of each, in A. E. M. U.
Let μ be the mutual electromagnetic capacity, or mutual inductance of L_1 and L_2 per cm. of each in A. E. M. U.
Let e be the primary circuit E. M. F., which is periodic in value.
Let n be the number of periods completed by e per second.
Let ω_1 be the impedance in the circuit of L_1 in A. E. M. U.
Let ω_2 be the impedance in the circuit of L_2 in A. E. M. U.
Let γ_s be the current in each of the two end telephones of the secondary circuit owing to electrostatic induction when electromagnetic induction is supposed to be absent.
Let γ_m be the current in each of three telephones in the secondary circuit (one of the centre of L_2 and the others at its ends), when electromagnetic action is supposed to exist between the circuits to the exclusion of static induction.
Let r be the radius of each wire (copper), in cms.
Let the wires be parallel and the distance between their axes be d cms. in the horizontal plane elevated h cms. above the ground.

Since γ_s and γ_m are periodic currents of the same frequency, they will produce equally loud sounds in the telephones when of equal numerical value, and the ratio of static to magnetic disturbance in the two cases will be

$$\frac{\gamma_s}{\gamma_m} = \frac{k}{\mu}\,\frac{\omega_1\,\omega_2}{2}.$$

Provided then, that the impedance of the primary circuit at the receiving end is always large, the ratio of static to magnetic disturbance will be approximately expressed by this equation. In order to apply it to the case of Fig. 2, we have to determine from the geometrical relations of the wires their mutual capacities k and μ.

The value of k in A. E. S. U. has been given by Mr. Oliver Heaviside in the *Journal* of the Society of Telegraph Engineers (London) for April, 1881 (with a misprint in the formula here avoided)

$$k = \frac{\frac{1}{2}\log_e \dfrac{\sqrt{d^2+4\,h^2}}{d}}{\left\{\log_e \dfrac{2\,h}{r}\right\}^2 - \left\{\log_e \dfrac{\sqrt{d^2+4\,h^2}}{d}\right\}^2}$$

Substituting for d 1.25 (cms. or half an inch.)
for h 1000 (cms. or about 33 feet.)
for r 0.1 (cms. or 0.04″ about representing No. 12 B. & S. gauge.)

$k = 0.0714$ A. E. S. U. $= 7.94 \times 10^{-23}$ A. E. M. U. or 0.0128 microfarads per mile.

The value for μ can also be found from another formula first published by Mr. Heaviside in the *Journal* of the above mentioned society for May, 1878, namely:

$$\mu = \log_e \frac{d^2+4\,h^2}{d^2}$$

from which $\mu = 14.75$ A. E. M. U. or 2.87 millihenrys per mile.

Thus for equality between γ_s and γ_m we must have with these values of k and μ

$$\omega_1\,\omega_2 = 3.717 \times 10^{23} \text{ A. E. M. U.}$$

Three telephones of 75 ω and 90 h each would, to a frequency of $n = 435$ corresponding to the note a^1, offer an impedance of $\omega_2 = 7.72 \times 10^{11}$ or 772 ohms, the impedance of the three telephones to this frequency being more than three times their resistance.

For $\gamma_s/\gamma_m = 1$, ω_1 must now be $3.717 \times 10^{23}/7.72 \times 10^{11}$ or 4.816×10^{11} or 481.6 ohms, in round numbers 500, while with the primary circuit of Fig. 2 having a transmitter of 165 ω and 730 h with a call-bell at the distant end of 550 ω and 2.7 H, the total resistance would be 715 ω, the total inductance 3.43 H, and the impedance to the same frequency of $n = 435$ would be $9.40 \times 10^{11} = 9400$ ω or about thirteen times greater than the total resistance. The impedance ω_1 is thus nearly twenty times greater than that needed by the formula for equality between γ_s and γ_m and roughly the static disturbance in Fig. 2 may be estimated as twenty times greater than the magnetic.

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[1] Abstract of a communication to the American Institute of Electrical Engineers.

[2] See THE ELECTRICAL ENGINEER, March 25, p. 366.

INTERNATIONAL PROTECTION OF INDUSTRIAL PROPERTY.[1]

BY COL. F. A. SEELY.

THE difficulty in securing international protection for inventions exists by reason of systems of law in many countries, under which an alien inventor is debarred from protection by reason of having first complied with the law in his own country. Much thought has been expended upon the removal of this difficulty, but the true and universal solution has been missed in Europe by the failure to take cognizance of radical differences in patent laws. Since in most countries the publication of a description of an invention constitutes a bar to the grant of a patent or vitiates one if subsequently obtained, it would seem that the difficulty would vanish if the nations of the world were to agree that such publication, when official, and in connection with the grant of a patent in any country, should not affect the inventor's right in any other.

The International Convention of Paris in 1883, while wisely planned in many respects, fails of its purpose when considered from an American aspect, because it failed to take note of special features of American patent law.

It established what is called a period of priority, running from the deposit of the application for patent, during which the inventor might file his application in the other countries accepting the convention, without having his rights affected by anything occuring in the interval, including publication or the grant of the patent to a third party. This works very well in countries where there is no examination into novelty, and where the publication follows the deposit after only a short interval. It does not work in the United States, because in most cases the whole period of priority expires before the grant of the patent in this country, and the inventor rarely is willing to take out patents abroad till he has secured them at home. If the period of priority had at first been adjusted so as to run from the publication rather than from the deposit, it might have been satisfactory to the other countries, and at the same time advantageous to the American inventor. This was the proposition of the United States that was voted down in the Madrid Conference in 1890.

The scheme proposed by the Pan-American Congress took no note whatever of the United States patent law. It was based on the laws of the majority of the South American States, which differ widely from ours, and the principal features of the scheme are wholly incompatable with our system.

Absolute reciprocity exists between this country and Canada, and the laws of Venezuela and Hawaii resembles ours in so many particulars that it may be said to exist with them also. By an amendment recently proposed to the German Law, to go into effect October 1st, that Empire practically accepts the American proposition which was refused at Madrid.

Our law fully recognizes the international principle; it is more liberal than any proposed terms of reciprocity. In fact, its very liberality constitutes a bar to agreements with other nations, because we have no concessions to make in return for those we demand. The wisest and most hopeful course for us appears to be, to take note of the concessions mutually made by other nations for the benefit of their own people, and secure to our own people the benefit of these concessions, which by our liberal legislation we are prepared to do.

"IN THE LEAD."

A well-known electrical engineer in Boston, writing of THE ELECTRICAL ENGINEER says: "Its able character has placed it in the lead of all other electrical papers published in this country."

MILEAGE OF ELECTRIC WIRES.

It has recently been estimated that there are 1,500,000 miles of operative electric circuit in this country, or enough to go 60 times around the earth at the equator.

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[1] A paper read at the Patent Centennial Celebration, April 8, 9, 10, 1891.

INSTITUTE DISCUSSION ON TELEPHONIC INDUCTIVE DISTURBANCES.

THE discussion of Mr. J. J. Carty's paper on "Inductive Disturbances in Telephone Circuits," was opened by **MR. A. E. KENNELLY**, who corroborated the results obtained by Mr. Carty, by calculations given in a *Note* on p. 450, this issue.

MR. CARTY :—I would like to describe a few experiments to prove that when a man is talking on one wire and his speech is heard by induction on a parallel wire, that that speech finds its way between the two wires by virtue of electrostatic induction, and that electro magnetic induction is entirely negligible.

I will first show what I consider the most favorable condition for creating electro-magnetic induction between two telephone wires. T, Fig. 1, represents the coil of a long distance transmitter sending the most powerful telephone current that it is now possible to generate. L^1 represents the wire connected to earth. It may be, we will say, 200 feet long. Parallel to it and an eighth of an inch away, we will place another telephone circuit. These wires may have an insulation of 10,000 megohms and the resistance might be considered as one ohm. Now a current resulting from a given note in the transmitter through the wire (L^1) produces a series of changes in the magnetic field surrounding it, and that action is roughly explained by assuming that the current starting in L^1 induces a current in L^2 in the opposite direction, and that the induced current will flow through both telephones *a* and *b*. Under those conditions absolutely no sound is heard in the telephones *a* or *b*.

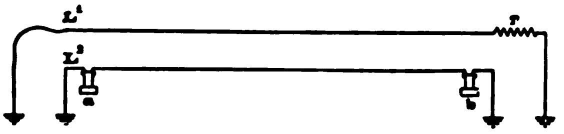

FIG. 1.

Now, I will describe another experiment which I made with those same wires. We will open the wire L^1 (Fig. 2,) at the far end. Then, when the transmitter is operated, noise is immediately heard at the telephones *a* and *b*, located at the ends of the secondary wire, and if a telephone, *c*, be located at the exact centre of impedance it will be found to be silent. When the wire L^1 is opened at the far end we have the maximum electro-static and the minimum electro-magnetic action ; when it is closed we have the maximum electro-magnetic action and the minimum electro-static action. The reason that the electro-static action is slight in Fig. 1 can be seen from Fig. 3. Assuming that *m n* represents the height of potential of the transmitter, the resistance of the circuit is mostly in the transmitter and the fall of potential therein is very sudden. At any point along the wire L^1 the potential would be practically zero, as shown by the dotted line *o p*.

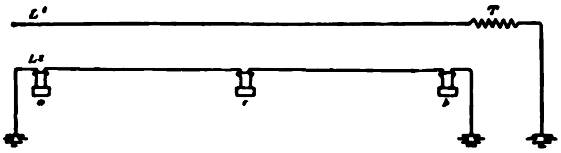

FIG. 2.

I wish to show another experiment in proof of the fact, or what I think is a fact, that electro-magnetic induction is negligible when we consider the action that goes on between two telephone circuits. I expressly limit the statement to the action between telephone circuits, and I am not discussing disturbances in general, but merely inductive cross-talk. We will assume that the circuit is completed by a return wire of no resistance, Fig. 4, or of very low resistance, entirely outside of the field of disturbance, so as to eliminate all questions of leakage through the earth. We will say that L^1 is grounded on a gas pipe. We then have the disturbing wire as before, and when the transmitter is operated loud tones are heard at the end telephones, *a* and *b*. If this were entirely due to the creation of an electro-magnetic field around the disturbing wire, the effect on the secondary wire would be increased by short-circuiting one of the telephones by the key *k*. Now, it is found that when this is done, instead of increasing the sound in the other telephone, it absolutely removes it. The case just described is another condition where you should get an increase of electro-magnetic action, if the disturbance is due to the magnetic field, but the noise, instead of increasing, disappears entirely. You will see how beautifully the thing may be explained by assuming that the disturbance is due to direct electro-static action. In this case we will say that the wire L^1, at a given instant, has a plus charge upon it which induces a minus charge on L^2. Now, when the inducing charge is removed the induced charge divides and flows away at both ends. But as there is a great deal of resistance in telephone *b*, and practically no resistance in key *k*, the charge and discharge of L^2 takes place up and down through the key end and none of it goes through the telephone *b*.

MR. GEORGE B. PRESCOTT, JR., inquired with reference to Fig. 1, whether Mr. Carty had tried the experiment of interrupting a battery current in the inducing circuit by means of an ordinary telegraph key.

MR. CARTY replied that he had employed a vibrator with a powerful current and had used the same secondary wire, and a telephone in the centre, and then found a noise in all three telephones, just exactly what one should expect in dealing with electro-magnetic induction.

MR. CARTY wanted it distinctly understood that his experiments referred only to the disturbance which is produced upon one telephone circuit by induction from another, and that in his experiments he had used the human voice for a disturbing source, and covered the entire range of telephonic currents.

MR. WM. M. MINER inquired if Mr. Carty obtained the same result when the wire that he used, L^1, was about three or four times the length of the secondary, and the secondary, say, a mile in length. He asked this question because in the city of Chester, Pa., and about a mile from the exchange, he had heard, distinctly, the superintendent at Wilmington, Del., about three miles away, talking with the operator at the Chester exchange ; the wires running parallel and both wires grounded.

MR. CARTY had never tried that experiment. He added that all of his experiments had been reproduced, using condensers, and the results from condensers were exactly those got from straight wires.

MR. CARTY :—I wish to point out that there must be some mistake in the reference given by Mr. Lockwood in his note. He says: "Mr. Culley presented a paper once upon this subject before the Society of Telegraph Engineers ; which paper, together with a most instructive discussion, is published in the journal of that society, and Mr. Preece and myself from time to time have also repeatedly referred to it." Mr. Culley has not read a paper of any kind before the Society of Telegraph Engineers or Electrical Engineers since 1875. That was before the invention of the telephone. Mr. Culley's paper of 1875 dealt with the induction of telegraph wires. I put in a foot-note referring to Mr. Culley's paper in my Electric Club paper. I think that that must be what Mr. Lockwood means. I am very familiar with Mr. Lockwood's writings, but I have never seen anything about that in print. If any one else present has, I think it had better be put on record, as the literature of the subject is meagre at best.

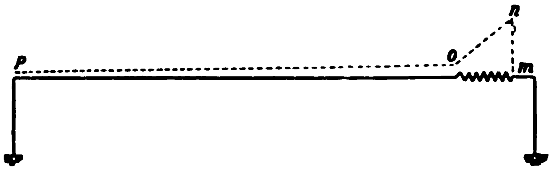

FIG. 3.

MR. H. FRANKLIN WATTS considered that electro-magnetic induction, pure and simple, was produced by magnetic whirls surrounding the disturbing wire. That being the case, was a wire open at one end capable of producing these whirls? If such a wire was *not* capable of producing whirls, then, in the cases to which Mr. Carty referred in which the wire is open, it was evident that it was due to something else besides electro-magnetic induction.

MR. CARTY thought it must be admitted that in the act of charging the wire a current flows, and even although the end be open, that current produces a magnetic field, and all of the effects, while it lasts, that would be produced by a current of the same character flowing in a closed metallic circuit.

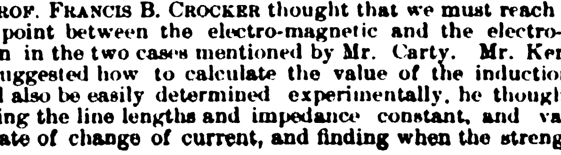

FIG. 4.

PROF. FRANCIS B. CROCKER thought that we must reach a balance point between the electro-magnetic and the electro-static action in the two cases mentioned by Mr. Carty. Mr. Kennelly has suggested how to calculate the value of the induction. It could also be easily determined experimentally, he thought, by keeping the line lengths and impedance constant, and varying the rate of change of current, and finding when the strength of the current or rather the rate of its change, reaches a certain value, at which the electro-magnetic effect is equal to the electrostatic effect. Evidently there must be a point somewhere between the two cases at which a sufficiently low impedance, or a sufficiently great electro-magnetic effect would give audible electro-magnetic inductive disturbances.

In reply to a question by MR. FRANCIS R. UPTON, MR. CARTY stated that 500 feet was the length of most of the lines used; but all of his practical experience confirmed the experiments on these lines, and the system employed to do away with disturbances is effective for both electro-magnetic and electro-static induction.

REGULATION OF CONSTANT CURRENT GENERATORS.[1]

BY ALEX. DOW.

ELECTRICAL power, expressed in watts, is a product of two factors, the electromotive force, and the volume of the current carrying the power. A change in the total power of the current may be expressed by a change of either factor, or of both. In distributions of electric energy it is usual to provide for adjusting the production to the requirements of the work by varying only one factor; the other being maintained constant from minimum to maximum production. Thus we have two commonly recognized methods of distribution, at constant electromotive force, and with constant current. There are cases in practice where both factors may vary; for instance, when a series wound dynamo operates one series wound arc lamp, or when a shunt wound machine is employed to charge one set of accumulators; but you will notice that in such cases there is but one device absorbing energy. Where there is more than one absorber the difficulty of keeping each of these in unison with the other compels the adoption of a one-factor regulation of the generator.

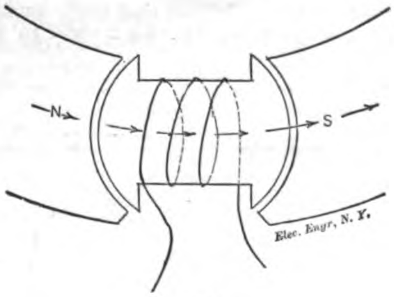

FIG. 1A.

The theory of the dynamo electric machine, as commonly taught, is that the electromotive force developed by any dynamo, depends on the rate at which the conductor under induction cuts lines of magnetic force. For purposes of this paper we will accept this theory; and as regulation of the output of a constant current dynamo means changing the electromotive force, we see that any method of regulation is necessarily a method of changing the rate of cutting of lines of force.

In practice this cutting is by the conductors of an armature revolving in a magnetic field, and we see several possible ways of obtaining a change of rate. We can change the velocity of the conductor, run the armature at a lower speed, and so do less cutting in a given time; or we can reduce the number of lines of force intersecting the path of the conductor, and so give the armature of the wires less lines to cut; or we can change the length of conductor, as the greater effective length of armature wire there is in the field, the more cutting it will do per revolution. Any of these, or any combination of them will serve to regulate the electromotive force.

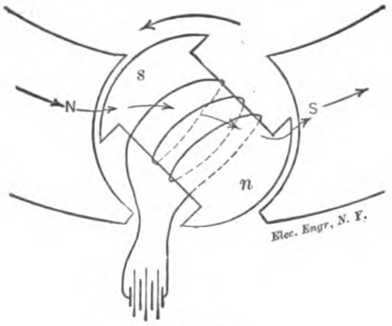

FIG. 1B.

The first way is the simplest and most efficient. Change of speed will alter the electromotive force of a dynamo, without complication and with absolute accuracy right down to the point at which it merely charges its own field magnets.

In water-power plants regulation by speed is common.

Regulation by changing strength of field has been brought to perfection in constant potential working, in the shape of compound winding. It is used also in constant current work, many of the most familiar devices depending primarily on change of field. But compound winding is not used to any extent, such winding for constant current being difficult. The first difficulty is to design a commercially and mechanically practicable shunt field for high voltages. Shunt wound arc dynamos have worked up to 1,200 volts, and worked well under favorable conditions. But 1,200 volts is too low for recent practice, and conditions are rarely favorable to an arc dynamo. With the open coil dynamos, which have two or three independent commutators connected in series, it is possible to compound by a shunt connected to one commutator only; the shunt thus taking half or one-third of the total voltage. Power generators of this type are doing excellent work, but the extreme changes of lead under variation of load, limit the applicability of these machines. Of course an automatic brush-rocker is suggestive as the one thing needed to make them generally useful, but to make a brush-rocker keep step with the instantaneous changes of field, is not easy. I believe that at present, when a sudden change of lead is required, the compounding acts quicker than the shifting brushes.

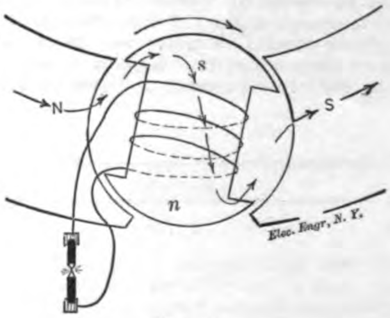

FIG. 1C.

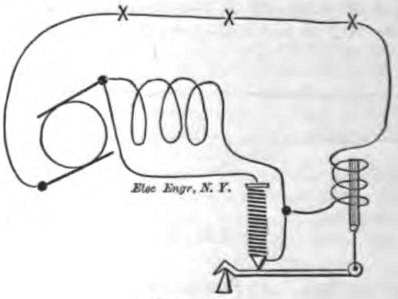

FIG. 2A.

Before taking up the study of regulators of the field changing class, I must say something about armature reaction, *i. e.*, the influence of the armature magnetism on the density of the field.

I want to make clear, by a few diagrams, the part which the armature of a dynamo constitutes in its magnetic circuit, and not begin by a definition of the magnetic circuit. I state its fundamental law, in order to lead up to the statements that follow. It is, that the magnetic flux in any circuit, that is, the total number of lines of force, or what we call the strength of field, is directly proportional to the magnetomotive force (ampere turns) and is inversely proportional to the magnetic resistance of the circuit.

Now, the magnetic circuit of a dynamo is a compound one. It is not all iron, or all air; it is iron and air and copper armature wire. The magnetic flux in this circuit under a given magnetomotive force, applied to the field magnets, can be caculated, when the armature is not traversed by current, from the known magnetic resistances of the iron and air and copper. But so soon as there is current in the armature the circuit becomes complex as well as compound. The armature becomes a magnet in its own right in virtue of the current circulating in its windings, and its magnetism may, and does, oppose that of the fields. So that the total magnetic flux or strength of field is changed, and changes further as the current in the armature increases.

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[1] Abstract of paper read before the Chicago Electric Club.

To illustrate this by my diagram. Fig. 1 *a*, let us conceive the armature to be free to move on its axis, but not traversed by current; and the field excited by a constant current from some external source. We have thus a magnetic flux from pole piece N to pole piece S, which takes as part of its path the iron core of the armature. Here we have an ordinary compound magnetic circuit.

Now we will conceive, Fig. 1 *b*, that the armature also is excited, from some internal source, in such manner as to produce polarization N and S. We have now a marked tendency to get attracted poles in line in such manner as to get the best magnetic circuit, to get the straightest path for the lines of force; or, we may say, in such manner as to form of the two independent magnets, the field and armature, one big magnet. This is what I call a complex magnetic circuit. There are two magnetomotive forces operating to produce a flux along the same path. Our diagram, as it stands, only needs a commutator and brushes to be a motor.

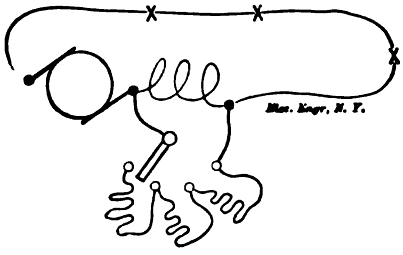


FIG. 2B.

Now we will conceive Fig. 1 *c*., that we have a belt on the armature pulley and are driving it up to speed, and that the ends of the armature coil are closed on one another, say, through an arc lamp. There will be currents induced in the armature coil, and these currents will polarize the core in such manner that each of its poles N. S. is attracted and held back by the field pole which it is leaving, and repelled by the field pole which it is approaching. That is, the work done in driving a dynamo, pulling attracted armature poles apart, and pushing them up to other poles which repel them.

Now let us examine the magnetic circuit as a whole. We have recognized the effect of the magnetic flux to secure the shortest path, the greater will be the flux. We will place the armature of our diagram in the position for maximum induction of current in its coil (Fig. 1 *c*.). The rotation is right-handed. Remembering that the pole of a dynamo armature which is leaving a field pole is always of the sign which that field pole would attract; we see that the upper armature pole is S and the lower N. Now let us lay out the course of the magnetic flux. We find that the lines which went straight across from N. to S. of the field magnet when the armature was not generating current, cannot do so now. They are repelled by the lower end of the armature and obliged to bend upward toward the upper end. I find it convenient to think of the reaction state as a lengthening of the magnetic circuit. The lines of force now take a crooked long path instead of the short straight path they had before the reaction commenced, and the effect on the field is just the same as if the magnets had been made longer, or the air space made wider. You do not get so strong a field when reaction sets in, although your exciting current or magneto-motive force remains the same. Indeed, in dynamos designed to take advantage of this reaction you do not get so strong a field for a greater exciting current.

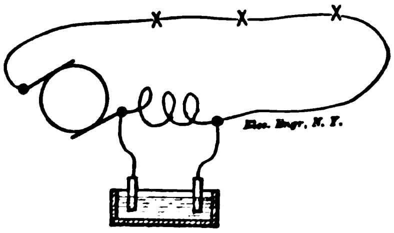


FIG. 2C.

The most familiar regulators of the field-changing class are those in which an adjustable resistance is connected in shunt to the field winding of a series dynamo as shown in Fig. 2 *a*, *b*, and *c*. We notice that wherever this is in successful use, the variation of the resistance is controlled by a small relay in the main circuit, and that the heavy mechanical work of the device is performed by magnets in a local circuit, or by the power driving the dynamo. The requirement for good practical regulation of an arc circuit, is that the relay shall be more sensitive than the arc lamp. It is frequently so delicate that it responds promptly to a variation of current of 1/4 of 1 per cent.

In Fig. 3 is shown another way of varying field magnet strength. It is in use on the Hochhausen dynamo and motor, and is quite accurate when the field is divided into many sections. A similar arrangement where the field coils, instead of being altered in number, are subject to permutations and combinations that vary the number in series, is in use on two systems of series wound street car motors. This does not work so well as the Hochhausen plan, because it is limited to a few gradations, and it is usually combined with a resistance called an "an easy-starting-coil" to make it less jerky in its operation.

Some of you may have been accustomed to think of the reduction of electromotive force under field regulation as due only to change of exciting current. The changes of lead under such regulation should indicate the actual process to an observer, but not one published description takes account of anything but the fall of field current. If you wish to understand clearly the process, I suggest that you put an armature in the field circuit of your dynamo. You will possibly find a reduction of electromotive force of 90 per cent. to follow a reduction of only 45 per cent. in the exciting current.

We come now to consider that class of regulators which operates by moving the brushes of a closed-coil armature. The most common explanation of this regulation is by the well-known "diagram of potentials," showing that near the neutral point the brushes are on the diameter of maximum difference of potential, and that 90 degrees distant, they would find a diameter of equipotential, and of course that any desired intermediate potential difference can be had on the proper intermediate diameter. And you can, by using a voltmeter—not the brushes—get just such a diagram of any of these machines; so of course the explanation is complete. But I have harbored for a long time the suspicion that this explanation did not explain. And this was what aroused my suspicion. I looked at the diagram and saw that if I rocked forward those brushes 45 or 50 degrees, I would get just half the maximum potential. Then I looked at a machine and found that if I rocked forward the brushes 45 or 50 degrees, I didn't get any potential at all. Then I looked at more machines, and more and more of them, and they all had this utterly unjustifiable departure from the diagram. I went to work on a 400 ampere machine with a voltmeter, and got a beautiful potential curve. Then I calculated the position which would give me 5 per cent. reduction in voltage, rocked the brushes forward, and got a 10 per cent. reduction. And so it was in every position in which I could try it.

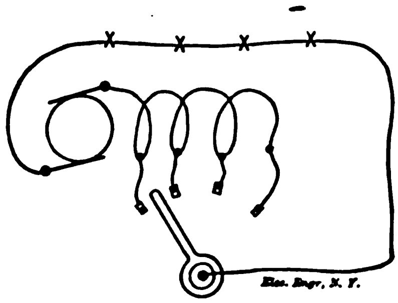


FIG. 3.

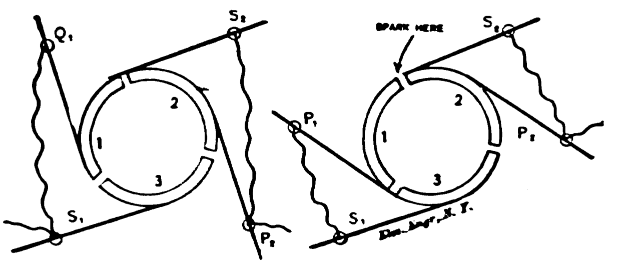
Then I got hold of a series wound dynamo and run it on a resistance. I rocked the brushes backward and forward as far as the spark would permit, and found that I could vary the current from maximum about 40 per cent. downward. Then I tried what effect varying the field current would have in comparison with changing the lead, and I found that variation of field current very much inferior, a little change of lead would neutralize all the variation I could control.

Here were two machines that had but one thing in common with the arc dynamos, namely, a strong armature compared with their fields. And they showed the same quality of regulation by brush rocking as did these special arc dynamos. My suspicion was becoming a theory at a rapid rate. And so I formulated the theory that regulation by brush rocking depended on armature reaction, and that consequently the essential condition to success under this method was a magnetic circuit in which the armature magnetism had large value in comparison with the fields.

Now there is one more method of constant current regulation in use that cannot be left out of any paper on this subject. It is regulation by changing the effective length of armature conductor, and its sole representative is a well-known open coil dynamo, the Thomson-Houston. You are doubtless familiar with the brush arrangements of this peculiar machine, and know that its regulation of E. M. F. is by a device which short circuits the armature. But to assist your remembrance, I have here two diagrams showing in Fig. 4 the full load and in Fig. 5 the minimum load positions of the brushes and their contact with the segments at these positions. Notice that in the minimum position the armature is absolutely short circuited from brush to brush during half of the revolution. That is, it is short circuited six times in each revolution and each time during 40 degrees of its movement, a total of 180 degrees. This period of short circuit is gradually reduced in its duration, although it still occurs six times per revolution, until the full load position is reached, when it is almost nothing. It would be absolutely nothing if it were not for the spark. The metallic contact is broken, but the spark under the tin of the secondary brush has conductivity like any other electric spark, and so gives a momentary short circuit.

The actions following the short circut of active armature coils are complex. We expect the most noticeable to be the development of a tremendous current in the short circuited coils with great heating, and our experience with short circuiting of individual sections of armatures would lead us to predict the early destruction of the winding from this coil. The facts do not bear out the predictions. The enormous short circuit current begins to develop but meets reactions which arrest its growth.

We have seen earlier in this paper that any forward change of lead signifies a lengthening of the magnetic circuit, and a consequent reduction of the field value. Thus the regulation is affected not only by removal from circuit of the conductors cutting lines of force, but also by actual reduction of the number of lines of force in the field. And further, this reduction of field is due both to a decrease in magnetomotive force, in that the exciting current becomes intermittent; and to increased resistance of the magnetic circuit in that the resultant polarity of the armature is displaced forward, virtually lengthening the path to be taken by the magnetic flux. The same reduction of field that affects the working circuit influences also the local circuit of the armature and aids in preventing any injurious increase of current or heating of the short circuited coils.



FIGS. 4 AND 5.

It will be asked why the operators of these dynamos avoid running them on a few lamps, and what cause there is for the frequent statement that they heat when working on a minimum load. The explanation is simple, if we again consider the action a periodical or intermittent currents.

We observe that as the load decreases the short circuiting becomes more lengthened and the currents delivered to the field coils becomes more markedly intermittent. These coils are wound on an iron core, and it is to the iron we must look for the heating. It is in exactly the same relation to the field coils as are the secondary winding and iron core of an induction coil to its primary, and it is not laminated as is the core of the induction coil, nor is it, like the secondary, provided with an external circuit for the utilization in external work of the currents developed in it. It is to these induced or Foucault currents, that we must attribute the heating of the dynamo at short loads.

The last point I can take up in this paper is the influence which the work a dynamo is doing has upon its regulation. Of course the work of a dynamo can be expressed as so many watts, no matter how the current is employed, but practical men recognize that certain classes of work, though they may not exceed in watts certain other classes are much more severe on the machine, and trying to the regulation. The motor circuit is notoriously the hard one; but many practical men have noted that there is a difference in facility of regulation with different arc lamps in circuit. Thus the differentially wound arc lamp, with a strong magnet in the main circuit is an easy lamp to regulate for. The discharge from the series magnet helps the dynamo during a momentary overload, and so does the shortening of the arc. But the shunt wound arc lamp is just the reverse. The discharge from its magnet goes through its own arc and for all small changes of current its action is to lengthen the arc for a decrease and shorten it for an increase, and so put more work on the dynamo regulator.

In conclusion I would suggest to you the adoption of the expression I have used for the armature reaction effect, namely: *Lengthening of the magnetic circuit.* I submit that the expression has the following advantage—it explains the observed effect—it conforms to the now generally received law of the magnetic circuit—it can be expressed in terms of magnetic resistence, just as can the effect of any other change of magnetic circuit—it admits readily of graphic illustration—and can be shown by an iron filings card taken from an actual dynamo.

The terms *armature reaction* and *cross magnetization* do not fit with the idea of the magnetic circuit. The expression of the effect as so many negative ampere turns has been employed but it is confusing to consider a condition as a reduction of magnetomotive force when that theoretical condition is accompanied by an actual increase of ampere turns. I propose to count all ampere turns of field and armature as positive, and to express the reduced magnetic flux following distortion of field as due to increased length and therefore resistence of the magnetic circuit.

THE PATENT CENTENNIAL CELEBRATION.

THE beginning of the second century of the American patent system was celebrated with due honors last week at Washington, by a convention of inventors, manufacturers, patent attorneys and others. The meetings extended over three days, and were well attended. The first public session was opened by President Harrison. A large number of interesting and valuable papers were read, and such as bear upon electricity will be found in full, or abstracted, in our columns this week. The proceedings were interspersed with receptions, excursions, etc.

PROF. THOMAS GRAY, of the electrical engineering department of the Rose Polytechnic Institute delivered an address on the "Inventors of the Telegraph and Telephone." It was of a very interesting nature, and historical in its treatment of the subject. He did not consider that any one man was entitled to the credit of inventing the telegraph.

In speaking of the relations between invention and research, **MR. F. W. CLARKE** said that a hundred years ago, in 1791, Galvani published his book on animal electricity, and at nearly the same time the Royal Society awarded the Copley medal to Volta. Between these events and the foundation of our patent office there was no obvious relation; but the science grown from those germs is now one of its chief objects of activity. At the time they were made, Galvani's work had no practical significance, and many other illustrations were cited by the speaker to show that applied science always has its roots in researches of a purely abstract nature. We can have no applied science unless we have the science to apply, and as it happens that the nations which encourage scientific investigations, acquire thereby industrial supremacy. The agencies which develop research are individual enterprise, schools and universities, scientific societies, and government aid. Of these the university is the chief, and in the university laboratories nine-tenths of the purely scientific discoveries are made. A true university is a producer as well as a distributor of knowledge, and by recognizing this fact Germany has become the leader of modern science. A chemist who has done no original work can have no prominent position in Germany. The speaker urged that training in pure research be more cultivated than hitherto in American schools, where now the so-called "practical view" prevails. The student should learn how to discover; how to solve unsolved problems; for that is the mainspring of modern industrial growth. Of Government aid to science the speaker said little, except to show that the relation was a material one, and that in receiving help from science the state should render help in return. He then went on to speak of the gaps in our knowledge, due to the individualism of workers, each laboring for himself without reference to what others were doing. Co-operation is necessary, and along lines where the inventors and manufacturers can help. There should be established laboratories for research, in which the problems too large for individual effort could be properly handled, and important physical constants determined. Such constants are of fundamental importance to pure and applied science alike, and their measurement should not be left to personal convenience. Some of the wealth reaped by the inventor from applications of science might well go back to its source as seed. The research laboratory, in which the workers need not be overloaded with other duties, is the great desideratum for chemistry and physics to-day.

PROF. R. H. THURSTON read a payer on the "Builders of the Steam Engine," as the founders of modern industries and nations. He remarked that "Since Watt, the work of improvement of the steam engine and its introduction has been largely done by American inventors, under the protection of the patent laws of the United States; and the country has reaped a magnificent harvest, as a result of this discreet sowing of seed in earlier days. Corliss made the modern steam engine, availing himself of a principle given the world by Frederick Sickels, and Fulton gave us steam navigation. The Stevenses carried into effect the ideas of Fitch, and a dozen inventors and constructors made successful the plans of the Stephensons in the building of the railways. And so, to-day, a ton of engine does the work of ten of the time of Watt; a pound of fuel gives ten times the power obtained from it in his day; a steamer now crosses the Atlantic in one-eighth the time demanded at the beginning of the century; avoidable wastes in the engine have been reduced from 80 per cent. to 8; a half ounce of fuel will transport a ton of cargo over a mile of ocean.

JUDGE ROBERT S. TAYLOR read a paper on "The Epoch Making Inventions of America." With regard to electricity he remarked that since Franklin drew the first submissive spark from Heaven, Americans have been foremost in the great field of electricity. The subjugation of this great force was begun when Prof. Morse taught it to talk. The steam engine is the breath and muscles, the telegraph the nervous system of the body politic.

In the production of electric light, man has come nearer to creation than anywhere else. He has produced upon earth the light of the heavens—a true sunlight in fragments. But the most gratifying of all inventions is the telephone. It imparts a new function to speech and a new sense to the ear. It introduces the epoch of neighborship without propinquity, and lengthens life by saving time.

The patent system of the United States rests on 22 words in the Constitution. What other 22 words ever spoken or penned have borne such fruit of blessing to mankind?

In his paper on "The Effect of Invention on the Railroad and other means of Communication," Mr. Octave Chanute, president of the American Society of Civil Engineers, said: Upon the land, inventors talk calmly of superseding the present maximum railroad speed of 70 miles an hour, with velocities at 120 to 150 miles per hour. Recent developments in electrical science have given good hopes for this, and both European and American inventors are experimenting. Among the latter may be mentioned the "Weems Electric" system, by which speed of 115 miles per hour have already been attained on a most imperfect track; the "Williams Port-Electric" system, of attracting forward at high velocities, a railroad car forming a magnetic core through a series of helices or coils charged with an electric current, and the "Chemin de Fer Glissant" or water borne railroad cars, which was exhibited at the Paris Exposition of 1889. Allusion may be made to the "Bicycle locomotive," with which it is claimed that far greater speed can be obtained than with the engines in general use; the principal object of inventors in every case, seeming to be to gain higher velocities than these which have hitherto been found practicable.

In the air, man gazes at the birds, and longs to imitate them. I know, personally, of eight or ten perfectly sane men in the United States, in England, in France, in Australia and in Egypt, who are experimenting with flying machines. Not dirigible balloons, with which a measure of success has already been accomplished, although only low velocities are to be expected from them, but real flying machines, depending like the birds upon the sustaining reactions of the air for their support.

Of these experimenters, probably the best equipped is Mr. Maxim, the inventor of an electric light and of the automatic machine gun, who made the remarkable statement last November, in a letter to the New York *Times*, that his experiments show that as much as 133 pounds may be sustained in the air by the expenditure of one horse-power; that he has succeeded in making a motor which will develop one horse-power for every six pounds of weight, and that a speed of 100 miles per hour would seem to be attainable.

If his experiments, which are now being carried on in England, on a large and skilful scale, succeed as he hopes, or is some other of the many inventors who are working on the problem, hits upon the right combination, there seems to be no reason why man may not emulate eventually the flight of the swallow, whose speed is computed at 150 miles per hour, or that of the swift or martin, which is said to flash through the air at the rate of 200 miles per hour.

At a meeting on Friday night of a large number of the inventors and manufacturers of patented articles, who had been attending the patent centennial celebration, a national association of inventors was formed and a constitution and by-laws adopted. Persons may become active, honorary, and associate members, and life members by the payment of $100.

Dr. Gatling, the inventor of the Gatling gun, was chosen President, and Gardiner G. Hubbard of Washington, Prof. William A. Anthony, President of the American Institute of Electrical Engineers; Thomas Shaw of Philadelphia, and the Hon. Benjamin Butterworth, of Ohio, were elected Vice-Presidents.

College Notes.

WORCESTER POLYTECHNIC INSTITUTE.

The course of electrical engineering at the Worcester Polytechnic Institute, occupies a period of four and one-half years, being for three and one half years identical with that of mechanical engineering. Ample accommodations for work in this department, and a full equipment of instruments and apparatus, are provided.

The Institute has received a gift from the Westinghouse Co. of two dynamos and a motor, together with lamps, switches, etc. The annual catalogue for 1891 shows the total number of students in the Institute to be 196. Prof. A. S. Kimball, Ph.D., of the Physical department, has charge of the electrical studies. Three students are now taking the special electrical studies.

Letters to the Editor.

WHO COINED THE PHRASE "DYNAMO-ELECTRIC MACHINE?"

To whom is rightfully due the credit of the introduction of the convenient and expressive term "Dynamo-Electric Machine?" Professor Silvanus Thompson, who is usually good authority, says in his treatise that the name "appears to have been employed by Dr. Werner Siemens, in his communication of January 17th, 1867, to the Berlin Academy, in which he described a machine for generating electric currents by the application of mechanical power, the currents being induced in the coils of a rotating armature by the action of electric currents which were themselves excited by the currents so generated." But, as a matter of fact, this paper which is in *Monatsberichte Akademie* (Berlin), 1867, p. 55, entitled *Ueber die Umwandlung von Arbeitskraft in elektrischen Strom ohne Anwendung permanenter Magnete*, and may also be found in translation in Keith's Schellen's *Magneto and Dynamo-Electric Machines*, I, 180. makes no mention of the term "dynamo." It appears, however, that William Ladd read a paper in March, 1867, before the British Association "*On a new form of dynamo-magnetic machine*" (see Brit. Assoc. Rep. xxxviii, 18 [1867]) and another one the following year entitled "*On a further development of the dynamo-magneto-electric machine* (Ibid, xxxviii, 19). Ladd also exhibited one of his machines, having a single field-magnet charging two armatures, one for maintaining the field and the other for doing the external work, which was placarded "*Dynamo-Magneto-Machine.* New Principle of Conversion of Dynamic Force," in the English section of the Paris Exposition of 1867. I have not succeeded in finding an earlier use of the term than that by Ladd above referred to.

F. L. P.

April 8, 1891.

THE COMMERCIAL FUTURE OF THE TELEPHONE.

It is generally believed by the public and by many inventors of telephonic apparatus, that, after the expiration, in 1893, of the famous Bell patent of March 7, 1876, the lawful monopoly now held by the American Bell Telephone Company will expire by limitation.

The hopes and expectations of the long suffering public are doomed to disappointment. The *present* monopoly of telephony, held by the American Bell Telephone Company under the Bell patent, will cease when that patent expires, but that company long since acquired inventions which will control absolutely the use of all forms of the microphone, which is the only and essential instrument now known by the public for the transmission of speech by means of electricity under the Bell system, which the Supreme Court said "consisted in the use of an undulatory current in a closed circuit," and to the use of that instrument the world is indebted for the practical use of the electric telephone.

The Supreme Court of the United States, in the opinion delivered on the 19th of March, 1888, said:

"Bell discovered that speech could be transmitted by gradually changing the intensity of a continuous electrical current in a closed circuit; but, if another discovers a different method or way of doing the same thing, and gets a patent for it, the two discoverers will be permitted to operate each in his own way without interference with each other."

It is sincerely to be hoped that the inventive genius of some of our electricians will soon discover that "different method," and relieve the public from the exactions of the great monopoly.

The microphone is the only instrument *now known* which will transmit speech in a practical way, and the owners of that instrument will continue to control the practical use of the telephone in the United States. Thousands of microphones, of various forms and shapes, have been invented, but they all will be subservient to the patent, which will hereafter be issued to the American Bell Telephone Company for the microphone.

The microphone was claimed in a caveat, filed in the Patent Office on 14th April, 1877, by Emile Berliner. The claim is in these words:

> In an instrument situated within an electric circuit, having two or more ends of the circuit brought in contact with each other, which points of contact can be loosened or tightened by vibrating one or both sides of each contact, thus diminishing or increasing the current of electricity passing through the contacts as many times as vibrations occur.

This claim describes the microphone, and is so broad and so clear that it covers all forms of microphones now known or which may be invented, and without the microphone, the present Bell telephone system is not a commercial or practical one.

Patentees of microphones now, for the first time, learn that their patents are worthless, and that the American Bell Telephone Co. own this invention, and that company also owns the invention of Thomas A. Edison of a similar instrument, for which he filed an application for a patent on 20th July, 1877. No patent for the microphone has been issued to Berliner or Edison under their application, for the reason that those two claimants were put in interference by the patent office, and the important point is that the interference has been kept alive, and has not been decided by the patent office.

The American Bell Telephone Co. owns both these inventions, and the decision of the patent office can be deferred from year to year by that company, as long as it may deem best for its interests, and that company, no doubt, will defer asking a decision from the patent office until a short time before the Bell patent of March 7, 1876, expires, and then a patent for the microphone will be issued for Berliner's method to the American Bell Telephone Co., which will run for seventeen years from the date of issue of the patent, thereby securing to that company a continuance of its monopoly until 1910, unless, as the Supreme Court said, "another discovers a different method from that of Bell."

It is hoped men of science and intelligent mechanics will endeavor to discover that "different method."

W. C. BARNEY.

BALTIMORE, April 4, 1891.

OWNERSHIP OF THE WHELESS PATENTS.

We observe in your issue of April 1st an article headed "The Wheless Underground Electric Company." This article states that the Wheless Underground Company, of Tacoma, incorporated with a paid up capital of $500,000, had recently come into possession of all Mr. Malone Wheless' interests in his electric railway inventions, and that these inventions cover the overhead and conduit systems, and furthermore, that THE ELECTRICAL ENGINEER some months ago fully described these inventions.

We must confess our great surprise that your journal should publish the above statements, cognizant as you must be by the business relations sustained with the undersigned company, that the patents above referred to are the exclusive property of The Wheless Electric Railway Company, of Virginia. We are very sorry that such statements as the above should have been published upon the authority of an irresponsible party, when a simple inquiry from the officers of this company would have elicited the response that The Wheless Electric Railway Company, of Virginia, owns and controls absolutely all of Malone Wheless' inventions for electric railways, both overhead and underground, and furthermore, the records of the U. S. Patent Office will disclose the fact that all improvements by Malone Wheless upon these systems are also the property of the undersigned company.

In order that the public be not deceived by these misleading statements, or the correspondence belonging to this company be diverted from its legitimate channel, by the article complained of, we request that you publish in your next issue the facts herein stated, and furthermore, that Malone Wheless has no interest in the said inventions to dispose of, such interest having long since been acquired by this company, and that this company will prosecute all parties infringing these patents.

THE WHELESS ELECTRIC RAILWAY COMPANY,
D. F. MERRILL, JR., *Secretary.*

WASHINGTON, D. C.

THE WHELESS ELECTRIC RAILWAY SYSTEM.

In the *Portland Oregonian* of April 2, 1891, appeared the following advertisement:

THE WHELESS ELECTRIC RAILWAY SYSTEM.—WARNING.

The public is cautioned that all the patents and inventions of Malone Wheless for overhead and underground railway systems are owned and controlled exclusively by the Wheless electric railway company of Virginia (office Washington, D. C.), and that any company using either of said inventions is liable to action for infringement. Special notice is hereby given that no licenses have been granted and that no person is empowered to grant licenses. The Wheless Electric Railway Company, D. F. Merrill, Jr., Sec., Washington, D. C.

When the promoters of the Wheless Underground Electric Company were preparing for organization they investigated fully the field of inventions relative to electric street railway systems and during this investigation became aware of the Company which is responsible for the above publication. We found that the company referred to had apparent title to sundry patents relating to improvements in electric street railways, the inventions being those of Mr. Malone Wheless, of Nashville, Tenn. We found upon further examination that the Company referred to held its titles under executory contracts with Mr. Wheless, and that Mr. Wheless had brought suit against that Company in the Circuit Court of the United States for the Eastern District of Virginia to cancel these contracts, and that suit is now pending. The devices covered by the patents of that Company, as far as we are concerned, are obsolete and not adapted to the work for which our Company was organized.

The result of this suit in no wise affects or concerns our patent interests as we are working under electric railway patent interests which are fundamental in their character and have no relation whatever to any patents now in the possession of the Company above referred to. While for business reasons the transfers of patents which the Wheless Underground Electric Company proposes to use in their work, have not been spread upon the records of the Patent Office, we have no objection to their becoming known, either by the Wheless Electric Railway Company of Virginia or the public.

We are surprised at this notice since we are fully aware that the Virginia Company cannot understand the nature of the patents which the Underground Company are working under.

WHELESS UNDERGROUND ELECTRIC CO.,
By A. A. HONEY,
Vice-Pres't & Gen'l Mgr.

Reports of Companies.

WIGHTMAN ELECTRIC MFG. CO.

President Harrison's son-in-law, Mr. J. R. McKee, has just been elected president of the Wightman Electric Manufacturing Company of Scranton, and the concern, which is affiliated with the Thomson-Houston Company, proposes to engage extensively in the manufacture of electric mining apparatus, for which there promises to be a great demand within a short time in the anthracite coal fields of Pennsylvania. The Wightman Company is at present engaged in the manufacture of electric street-car supplies at its Scranton establishment, but with the application of electricity to mining it expects to occupy a large and profitable field of usefulness.

Mr. McKee enters the Wightman Company as one of the representatives of the Thomson-Houston interests, the other representatives of the same interest being H. M. Byllesby, O. T. Crosby, and Winthrop Coffin. Messrs. Lathrop R. Bacon and J. B. Newcombe, of New York, and the Hon. Alfred Hand and Col. George Sanderson, of Scranton, withdrew recently from the Directory to make way for these gentlemen. The other officers are Merle J. Wightman, vice-president and electrician; Herman Bergholtz, general manager and consulting engineer; and Horace E. Hand, secretary and treasurer.

It is claimed that inventions are now in course of development that will greatly facilitate the general introduction of electricity in the work of mining. The Wightman Company will control the patents connected with these inventions.

ELECTIONS.

DERRY, N. H.—Prof. E. K. Angell has been elected president of the Derry Electric Light Company.

BROOKLYN, N. Y.—The annual election for officers, directors and inspectors of election of the Brooklyn Electric Light and Power Company resulted as follows: Directors, Thomas Black, Stephen J. Burrows, Charles A. Smylie, Theodore Dow, Edward S. Seeley, Henry H. Downes, Adolph E. Smylie, E. Smith Nevins, Augustus P. Avery. Inspectors of Election, James Davey, Jerome Taylor, Walter A. Pendleton. The following are the officers: President and general manager, Charles A. Smylie; vice-president, Stephen J. Burrows; secretary, Thomas Black; treasurer, Adolphe E. Smylie.

DIVIDENDS.

NEW YORK CITY.—The local Edison Electric Illuminating Co. has declared its twenty-fourth quarterly dividend of 1 per cent. payable May 1.

Appointments, Etc.

MR. GEORGE EMMET has recently been appointed superintendent of the Attleboro Electric Railway.

MR. CHARLES HARRY, late superintendent of the Bay City, Mich., Electric Railway, has accepted a similar position with the Eau Claire, Wisconsin, Electric Railway Light and Power Company.

MR. W. A. GILES has been given charge of the mill, mining, marine and metallurgical departments of the Edison General Co.'s Eastern district.

MR. R. R. TOVEY has handed in his resignation as electrician for the Butte, Mont., Electric Light Company. Mr. Tovey has been in the employ of the company for the past five years.

MR. L. H. KINNARD, JR., of Harrisburg, has succeeded Charles A. Matcham, as manager of the telephone exchange in Lancaster, Pa.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 7, 1891.

Alarms and Signals :—

Automatic Electric Block System, J. A. Carlton & H. L. Johnston, 449,731. Filed Dec. 8, 1890.

A system of indicating by the automatic making and breaking of electric lighting circuits the presence of a train in a block division of a railway, or the exit of a train therefrom.

Automatic Railway Signal, C. W. Wilhelm, 449,990. Filed Sept. 23, 1890.

A device by which a signal is set at a certain station by a passing train, partially released when the train has passed a specified point and wholly released when the train has passed a more distant point, the train having set a second signal after partially releasing the first signal, but before wholly releasing it.

Train Signal, H. J. Finn & J. A. Garner, 449,672. Filed Nov. 14, 890.

Provides means by which the conductor and engineer of a train may be in direct communication at all times.

Non-Interference Electrical Signaling Apparatus, A. Newman, 449,690. Filed Feb. 28, 1890.

A signal-box and system applicable to district telegraphs, fire-alarms and police-circuits.

Auxiliary Fire Alarm and Extinguisher System, E. L. Slocum, 449,829. Filed Jan. 14, 1889.

Provides a system of alarm bells distributed about a building and a connecting system of water pipes and distributing heads, by which an alarm may be sounded in case of fire and any department or division of the building may be flooded with water.

Bell, A. F. Stanley, 449,832. Filed May 29, 1890.

Relates to the construction of the armature and hammer which are integral ; the hammer disc at the end is perforated and a peen of other metal is attached for striking the bell.

Automatic Bell Ringer, W. W. Slater, 449,866. Filed Jan. 6, 1891.

A combination of pneumatic and electro-magnetic apparatus for an alarm bell.

Conductors, Conduits and Insulators :—

Electric Connector, G. K. Wheeler. 419,721. Filed Nov. 26, 1890.

For connecting conducting wires to relatively large conductors such as railway rails. Consists of a tapered thimble or spool having a solid driving head and split for a portion of its length to form spring-jaws for clamping the wire when the spool is driven into an opening.

Insulator, L. McCarthy, 449,943. Filed Jan. 16, 1891.

Consists of a bell or case adapted to hold a series of sheets of mica, a metallic supporting piece placed therein, and a series of sheets of mica surrounding such piece and insulating it from the bell or case.

Dynamos and Motors :—

Automatic Switch for Electric Motors, W. Baxter, Jr., 449,660. Filed Oct. 21, 1897.

Relates to the class of "cut-outs" adapted to prevent the burning out of insulation and wire in a constant potential motor or dynamo by an excessive current ; the device shown and described is adapted for starting a motor or dynamo by hand and for opening the circuit automatically should the strength of the current exceed a safe limit.

Commutator for Electric Motors, H. Duenner, 419,774. Filed Oct. 16, 1890.

Consists in mounting the brushes upon a spindle which is movable longitudinally and applying cross head slides and an adjusting screw so that by a single turn of the screw the brushes may be adjusted longitudinally. To prevent the wearing of the commutator in circumferential grooves.

Electrolysis :—

Apparatus for Electroplating Small Articles, F. W. Zingsem, 449,890. Filed Oct. 17, 1890.

In a solution tank a shaft is supported in conducting bearings of the tank and a rotary reticulated drum of non-conducting material is attached to the shaft ; a conducting wire is connected to the shaft and is extended spirally through the drum.

Galvanic and Thermo-Electric Batteries :—

Carbon Electrode for Electric Batteries, E. A. Le Sueur, 450,105. Filed Oct. 14, 1890.

Consists of a number of pieces of rough carbon cut to unequal lengths and having rough uncut sides, and a metallic backing in which the carbon pieces are embedded at one end.

Lamps and Appurtenances :—

Electric Arc Lamp, E. Thomson and E. W. Rice, Jr., 419,715. Filed Apr. 9, 1885

Relates to means for feeding the carbon rod or pencil by a clutch, clamp or feed device acting directly upon the carbon rod or pencil instead of upon the metallic rod or bar to which the carbon is usually attached.

Cut-Out, A. T. Tregurtha, 419,767. Filed Feb. 25, 1889.

Details of design and construction of a cut-out shown as applied to an incandescent lamp.

Circuit Breaker for Incandescent Electric Light Systems, F. Müller and J. G. Greene, 449,780. Filed July 23, 1890.

Designed to check the consumption of current upon circuits that are not provided with a meter. The device is designed to permit a predetermined number of lamps to burn without interruption, but it will immediately break the circuit and extinguish the lamps if more than the predetermined number of lamps are turned on.

Electric Cut-Out, A. T. Tregurtha, 419,921. Filed Apr. 17, 1890.

Design and construction of a cut-out shown as applied to an incandescent electric lamp.

Electric Lamp for Street Lighting, H. H. Carpenter, 450,000. Filed Feb. 19, 1891.

A portable electric lamp and post for street lighting and similar purposes. Includes a case or closet forming the main stem of the post, fitted with shelves to contain storage batteries.

Cut-Out, J. S. Gibbs, 450,101. Filed Feb. 11, 1891.

A cut-out for multiple incandescent lamps.

Measurement :—

Ammeter or Voltmeter, H. C. Shubert, 449,766. Filed Oct. 31, 1890.

Consists in the combination, with two opposed soft-iron plates enclosed within an encircling coil included in the electric circuit, one of which is fixed and the other secured to a spindle carrying an indicating pointer, of a coiled spring governing the spindle and a regulating lever controlling the spring for its adjustment ; the spring operates when adjusted to produce a contact of the soft iron plates, so that the repulsion of the plates when magnetized by a current in the coil may be measured by the tension of the spring to indicate the amount or force of the current.

Metallurgical :—

Process of and Apparatus for Separating Ores Electrically, C. M. Ball & S. Norton, 449,726. Filed June 30, 1890.

Amplification of the invention patented to the same persons June 10, 1890, No. 430,058. The present invention consists in passing the crushed or granulated mass through a consecutive series of magnetic fields, while impressing on the mass degrees of tangential inertia differing in the successive fields of magnetic force.

Metal-Working :—

Method of Electric Welding, E. Thomson, 449,836. Filed July 11, 1890.

Designed to preserve the original character of the metal, adjacent to a joint, without changing the cross section of the finished work. Consists in expanding or upsetting the metal of the work either before or after the welding operation, and then employing rolling, or other reducing operation for restoring the character of the metal.

Miscellaneous :—

Electrical Hoisting Machine, W. Baxter, Jr., 449 661. Filed Mar. 2, 1888.

Consists mainly in the combination of a motor having only two magnet cores with a drum and worm-gearing upon a single bed, the whole forming a complete organized portable machine and the bed forming the bridge or yoke of the two magnet cores. Details relating to other features are included.

System of Operating Electric Elevators with Landing Switches Only, W. Baxter, Jr., 449,662. Filed April 20, 1888.

Adapted to control the movements of a car or platform carrying no operator, such as dumb-waiters or freight-hoisting platforms.

Electrical Dental Engine, F. F. Eggers, 449,847. Filed Dec. 10, 1890.

Consists of a motor journaled and rotating directly in the movable bracket of the apparatus, means for stopping and reversing the motor and for disengaging it from the mechanism.

Electric Valve Controller, G. E. Turner, 449,889. Filed Aug. 12, 1890.

Consists of a peculiarly constructed wheel operating with a step-by-step movement to reciprocate the valve, and an electro-magnetic apparatus for imparting the step-by-step movement to the wheel.

Lightning Arrester, J. W. Easton, 449,908. Filed Aug. 14, 1890.

An electro-magnetic apparatus energized by the passage of a lightning discharge separates the ends of the electrodes of the arrester sufficiently to avoid the formation of an arc and interrupts the circuit, upon which the electrode falls back to its normal position.

Electrical Lock, H. Grefen, 450,068. Filed May 19, 1890.

Peculiarly constructed bolts in combination with electro-magnetic apparatus for controlling them.

Railways and Appliances :—

Propelling Mechanism for Electric Motor Cars, S. H. Short, 449,709. Filed Dec. 11, 1890.

The armature of the motor is mounted directly upon the driving axle and the field magnets are mounted on short hanger-frames, pendulously suspended from the car axle, preferable between the wheels, so as to bring the journals close to the motor ; field magnets are held from rotation by a connection with another part of the car.

Electric Motor Car, H. P. Brown, 449,752. Filed May 26, 1890.

The armature shaft of the motor may revolve continuously, while the speed of the car and the amount of force communicated from the motor may be varied as desired or stopped altogether. Employs a grooved driving pulley receiving motion from the armature shaft and a grooved pulley by which motion is communicated to the axle, a rope connection between the pulleys and a rope tightener pulley.

Electric Railway, E. M. Bentley, 449,792. Filed Jan. 30, 1888.

Provides a trolley adapted to ride upon the supply conductor with a pulling wire or rope having a shifting point of connection therewith, so that the trolley can be pulled from one side or the other of the main conductor as desired. The patent also includes a switching device by means of which the trolley can pass from the main to a branch conductor without interference from the guards.

Electric Railway, R. M. Hunter, 449,797. Filed Dec. 15, 1888.

In a double track railway provides a conduit structure between the two tracks, having two slots, one for each track.

Electric-Car-Stopping Device, G. W. Blanchard, 449,843. Filed Oct. 16, 1890.

Consists of a locking device for the gears of an electric motor in combination with an electro-magnetic apparatus for normally holding the locking device out of engagement with the gear.

Trolley Support for Electric Cars, F. Robinson & P. W. J. Lander, 449,886, Filed Jan. 12, 1891.

Details of design and construction of the connecting devices between the roof of the car and the trolley arm.

Electric Railway, R. M. Hunter, 450,074. Filed May 29, 1889.

Employs a supply conductor and a working conductor connected in parallel and suspended upon the opposite sides of poles at an elevation above the track and so that the working conductor is adjacent to the track ; provides a laterally moving collector upon the car making a travelling contact with the suspended conductor upon its other side.

Telegraphs :—

Telegraphy, F. Anderson, deceased, 449,655. Filed May 31, 1890.

A system of automatic transmission.

Telegraphy, R. G. Brown, 449,897. Filed June 27, 1887.

Relates to synchronous-multiplex telegraphy. Provides a special connection for carrying away the static discharge, and utilizes that discharge for making a record at the sending station.

Telephones and Apparatus :—

Multiple Telephony, W. W. Jacques, 449,679. Filed Dec. 1, 1890.

Claim follows :

The combination, with three or more line wires of a telephone system at each end thereof, of an equal number of Muirhead condensers and an equal number of telephone loops, each of said line wires being connected with a separate armature strip in said condensers, and each loop being connected with two conducting strips in said condensers.

Electrical Switch-Board, J. B. Lyon, 449,685. Filed Nov. 20, 1890.

Relates to the manner of arranging the connecting wires behind telephone switch-boards of the multiple type, and designed to secure greater compactness.

Society and Club Notes.

NEW YORK ELECTRIC CLUB.

The annual election of officers of the New York Electric Club for the year beginning May 1, 1891, will be held at the Club House on Thursday evening, April 16, when the polls will be open from 5 to 8. The club has lately been enjoying large accessions of membership under the vigorous policy of President Madden, who has declined to serve again; and great interest is taken in the results on Thursday night, as at least two tickets are expected to contest the field.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the monthly meeting of the Institute to be held on April 21, at 8 P. M., at the headquarters, 12 W. 31st street, Mr. A. S. Brown, of Boonton, N. J., will read a paper on "The Electrical Extraction of Aluminum," illustrated by lantern slides. It is also expected that Mr. N. D. C. Hodges, Editor of *Science*, will bring before the Institute that evening his new theory and practice of lightning protection.

BROOKLYN INSTITUTE.

An interesting paper on the telephone will be presented before the Electrical Department on Friday, April 17, by Mr. E. H. Lyon, of the Metropolitan Telephone Co.

Legal Notes.

TROUBLE OVER AN ELECTRIC LAMP.

Mr. Fred H. Thwing, president of the American National Bank, of Arkansas City, Kan., which suspended recently, has been arrested on a United States warrant. The plaintiff, who is named Munson, charges that Oct. 1, he owned a half-interest in a patent electric lamp. Thwing visited Chicago and negotiated for Munson's interest, giving in payment a certificate of deposit for the amount on the American National Bank. The bank failed and Mr. Munson sent his certificate of deposit to Receiver Hatch, who refused to recognize it because Thwing had never made a record of it upon the bank's books. Thwing was taken before Judge Bonsall and his bond fixed at $10,000 for his appearance.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of April 11, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	81¼	Edison Gen. Elec. Co.	98
American Tele. & Cable	88	Consol'd Elec. Lt. Co	...
Centl. & So. Amer	*145	Edison Illn'g Co. N. Y.	78
Mexican	*210	U. S. Elec. Lt. Co.	80
Com. Cable Co	105	North Am. Phonograph	....
Postal Tel. Cable	89		

BOSTON.

	BID.		BID.
Thomson-Houston	46½	Ft. Wayne Co.	12½
" Pref'd.	25¼	Am. Bell	49¼
" Series C.	9½	Erie	51
" " D.	7	New England	.85 cts.
" Int. Co.	....	Mexican	.85 cts.
Thomson Welding Co.	....	Trop. American	.50 cts.
Thomson Eu. Welding	...	Edison Phon'gph Doll.	....
Westinghouse El. Man. Co.	13		

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	157
Ches. & Pot. Telephone	57½	Eck.&Sold. Home Elec. Ry.	56
Amer. Graphophone	5¼	Georgetown & Tenallytown	62

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

A steady, persistent advertiser rarely knows dull seasons.

THE LOOMIS INCANDESCENT SYSTEM.

A very handsome and interesting catalogue has recently been issued by the Eureka Electric Co., of 18 Broadway, relative to the Loomis system of arc and incandescent lighting which they control. The catalogue is profusely illustrated with perspective and detail views of the apparatus, including dynamos, arc and incandescent lamps, switches, cut-outs, ammeters, voltmeters, rosettes, pendants, motors, etc. All the parts of the system are carefully described, the advantages and points of superiority being pointed out. At the end are given a number of testimonials, and a sheet is inserted showing a long list of installations.

TEST OF THE TAYLOR PRIMARY BATTERY.

In a recent test, made for the third lighthouse department, of the Taylor primary battery, a Lugo motor was run for 76 hours on one charge, and developed nearly ¼ h. p. continually. The expense for the solution during the 76 hours amounted to 12 cents. Experiment are now being made in order to select the best motor for revolving the lights on light ships.

Attention is called to the card of Messrs Taylor and Son, in our advertising columns. The battery is attracting unusual attention.

THE WIRT LIGHTNING ARRESTER.

The Electrical Supply Co., of Chicago, reports a growing sale for the Wirt lightning arrester. This protective device is being largely used in electric railway work, its simplicity and compact form making it especially suitable for use in exposed places and on rolling stock. "An ounce of prevention is worth a pound of cure," and the Wirt arrester has, it is pointed out, always this distinct advantage over the most ingenious arc breaking devices, it *prevents* the forming of an arc in the first place.

THE BRISTOL, TENN., BELT LINE RAILWAY CO.

The Bristol Belt Line Railway Co. and the Bristol Street Car Co. have been bought out by Mr. A. H. Leftwich, of Spartanburg, S. C., and Mr. W. A. Stadelman, of Philadelphia, Penn., who have already begun the work of consolidating these roads, and changing them to an electric railway, under the name of the Bristol Belt Line Railway Co. Mr. S. L. Nicholson has been made superintendent of the road, and a large force of men are now at work planting the poles, laying track, etc. The road will be over eight miles long, and five cars will be put in use at once. Compound condensing engines, and steel tubular boilers, will be placed in a brick power house, which is now being built. A frame car house 50 feet by 80 feet is being erected. It is expected that the road will be in operation by the middle of June. The "Rae" system will be used. Two 40 h. p. equipments, and three 30 h. p. equipments, and one 65,000 watt generator will make up the electrical equipment.

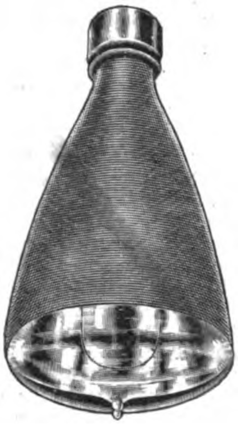
W. R. FLEMING & CO.

W. R. Fleming & Co., New York managers for the Foundry and Machine Dep't, of Harrisburg, Pa., have just put two of their engines into the H. C. F. Koch & Co. building, 125th street, New York city, which are to run four No. 2 dynamos. The engines are of the "Ideal" self-oiling type, which are meeting with great success in New York and vicinity. They run entirely in oil, a very novel feature in engines which engineers are beginning to appreciate. These engines were built to order on specifications furnished by the Koch Co. Like most of the engines furnished by the Fleming Co., these are 12" x 12" and 10½" x 10", neat and handsome in appearance, as well as heavy and serviceable for electric light duty. Koch & Co. will have no trouble with flickering lights. Fleming & Co. are building up a fine business in the installation of engines and complete steam plants and their success is mainly due to their experience, and that they let nothing but first-class work pass out of their hands. The Grand Central Depot plant is one of the first installed by them in New York, and is a very good sample of all their later work, being a perfect running plant. These engines, etc., are built at the factory at Harrisburg, Pa.

THE HALLETT LAMP.

THE demand for a first rate desk lamp that will throw its light where needed and not affect the user's eyes injuriously, seems to be filled very acceptably by an article being introduced by the Central Electric Co., of Chicago, and illustrated in the cut.

This lamp differs somewhat in shape from the ordinary incandescent lamp, its sides being almost straight, while the bottom, or large end, is as nearly flat as possible. These straight lines are necessary in order to obtain proper reflecting surfaces, and to prevent as much as possible, uneven intensities of light upon the object. The inside of the butt and the outside of the globe are silvered, and the incandescent filament is actually surrounded on three sides by a mirror reflecting all of the light downward. While the lamp may be placed on a level or a little above the level of the eye, no light strikes the eye directly from the lamp, as the silvering is covered and protected by an opaque substance. The lamp is made to fit any socket, and the new features are covered by strong patents.



THE HALLETT LAMP.

A NEW WASHBURN & MOEN ROLLING MILL.

The new rolling mill for the Washburn & Moen Mfg. Co., at Waukegan, Ill., will be quite extensive. The main building will be 140 ft. in width by 400 ft. in length, with a wing on one side 40 ft. in width and 160 ft. long, and one on the opposite side 40 ft. in width by 100 ft. long. The building will be entirely of steel, designed and built by The Berlin Iron Bridge Co., of East Berlin, Conn.

ELECTRIC LIGHT FRANCHISE IN SANTO DOMINGO.

The Government of Santo Domingo has granted a franchise for public and private lighting either by gas or electricity, for a period of 45 years, including rights of way on all the streets and highways of the capital of Santo Domingo. During the first ten years of this period the franchise is an exclusive one. The city of Santo Domingo has pledged itself to take 80 arc lights at $240 per annum, and to pay the same rate for all additional lights it may require. For each incandescent lamp it will pay $1.75.

It is estimated that over 1,000 incandescent lamps can be placed at once, and for private lighting the company is not restricted as to price. The suburb of San Carlos is also included in the franchise.

The owners of this franchise desire to open negotiations with parties, for the purpose of putting in an electric light plant, and offer liberal inducements to investors. Full information can be obtained by addressing the Editor of THE ELECTRICAL ENGINEER.

CLAY, PEPPER & REGISTER.

The above is the style of a new firm that has just been formed to do an electrical engineering and consulting business at 1,218–1,220 Filbert street, Philadelphia. They are also agents for the American Circular Loom Co. and the American Electric Elevator Co. The old firm of Clay & Pepper has carried on business in Philadelphia for nearly two years, and Mr. Register, who now joins it has been connected with the Railway Department of the Thomson-Houston Co. The new concern will make a specialty of wiring work.

OLD TIME TELEGRAPHERS.

About thirty old-time telegraphers assembled in the rooms of the Board of Trade, Washington, D. C., recently, to make preliminary arrangements for the entertainment, etc., of the members of the Old-Time Telegraphers' Society, which will meet in Washington next August.

THE SHAW ELECTRIC CRANE CO.

The removal of the Shaw Electric Crane Co. from Milwaukee to Muskegon, Mich., is announced, the contracts having been signed, and the company re-organized under Michigan laws. The shops are to be ready for occupancy early in August, and the company intend that they shall be the most completely equipped shops of their kind in the country. Business is very prosperous with the Shaw Company, and during the ensuing year they expect to more than double the output of last year. Among the orders received within two months are two cranes of ten tons capacity each, one for McIntosh, Seymour & Co., of Auburn, N. Y., and the other for the Whittier Machine Co., of Boston; one of five tons capacity for the Standard Elevator Co., of Chicago; and one for the Ball & Wood Co., of New York.

CLOWER, HARRIS & CO.

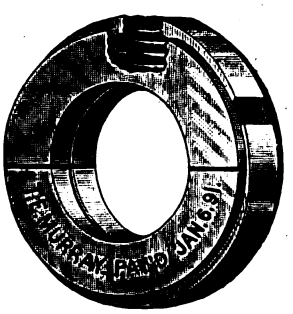
The old concern of Clower & Harris, of Dallas, Tex., has made a change of firm name and location. The new name, as given above, signifies the addition to the concern of Mr. E. T. Lewis, a well-known capitalist of Dallas. The new location is 289 Elm St., where they have fitted up the finest and largest electrical supply house west of the Mississippi river, with a large shop for repair work. The firm with its reorganization enters upon a career of greater activity and prosperity than ever.

THE GORDON SYSTEM OF ELECTRIC TRACTION.

The experiments carried out at Messrs. Merryweather & Sons, Tramway Works, Greenwich, England, on behalf of the Gordon Electric Car Syndicate, are said to have given encouraging preliminary results. The track has closed conduits, and the general idea of the system is a series of contacts actuated by means of an automatic magnet in a box placed in the ground every hundred yards or so—about 16 to a mile. The preliminary trials have been made in all sorts of weather, and with very severe tests, such as flooding the whole track of 70 yards with water, working in snow, fog, and so forth. The working pressure is 250 volts and the current 30 amperes.

METALLIC PISTON ROD PACKING.

THE accompanying illustration shows a novel metallic packing for piston rods, designed by Mr. T. E. Murray, of Albany, N. Y.



MURRAY METALLIC PISTON ROD PACKING.

The stuffing box is simply filled with the rings, the joints being broken by each ring, and then being screwed down tight. This packing is easily put in place, is automatic in its action, requires no attention, will not score the piston rod, and is extremely durable. It is manufactured by the Murray Metallic Packing Co. of Albany, N. Y.

THE JOHN SCOTT LEGACY MEDAL FOR INTERIOR CONDUITS.

Mr. E. H. Johnson, of this city, in a recent paper read before the Franklin Institute, gave an exhaustive description of the system in use by the Interior Conduit and Insulation Co., for house and underground wiring. His address, which was heard with much interest, appears in the journal of the Franklin Institute for March. In the same number is published the report of the sub-committee of the Committee on Science and the Arts, recommending the award of the John Scott Legacy Medal and Premium to the company. The recommendation was adopted by the committee. The sub-committee consists of the following: Carl Hering, chairman; T. Carpenter Smith, Richard W. Davis, E. A. Scott and Wm. McDevitt.

THE STANDARD ELECTRICAL WORKS, Cincinnati O., are enjoying an extensive and prosperous trade in electrical supplies of all descriptions. They are doing a large and growing street railway business, in which line they have many specialties. The present business in all departments is brisk, and the outlook very encouraging.

THE WHEELER BOILER AND WATER PIPE COVERING.

The great saving of fuel occasioned by the use of boiler and pipe covering has led to its almost universal adoption, even when, as is frequently the case, it is known to be inflammable, and is condemned by the insurance companies on that account, or when it has the property of eventually rusting the metal to which it is applied.

To overcome both these difficulties, Messrs. G. E. Wheeler & Co., of Piedmont, Ala., are manufacturing a material that, for the past six years, has enjoyed a constant and ever growing popularity. As a non-conductor and non-combustible covering it is claimed to have no equal. Being a fire-proof cement, applied directly to the boiler or pipes, it will not char or burn, and gives perfect safety from fire where pipes come in contact with beams or partitions. It dries in a few hours after applying, making a solid and cool surface, and has been used on boilers subject to all kinds of weather and exposed to both snow and rain, without any harm to the material.

The manufacturers are in receipt of the most flattering testimonials from steam users in all parts of the country.

NEW ENGLAND TRADE NOTES.

The Leach and Grant Co. has been organized in Boston with a capital of $50,000 to do a general contracting business. Mr. H. L. Grant is president, Mr. H. W. Leach, treasurer, and Mr. H. E. Grant, general manager. They will succeed to the business of H. W. Leach, & Co., and with the new capital will have facilities for largely increasing the business. The Leach and Grant Co. are masons, contractors and builders, and make a specialty of electric light and power plants. All three officers of the company have been for years connected with this class of work, and are well qualified to fulfil all work entrusted to them. Their headquarters will be, as before, at 243 Franklin street, Boston.

The Wainwright Manufacturing Company of Massachusetts have recently sold the following apparatus:—Two 300 h. p. compound engine heaters for the Municipal Electric Light Company, Brooklyn, N. Y.; two 120 h. p. surface condensers to the North Hudson County Railway, Hoboken, N. J.; one 300, one 200, and one 100 h. p. heaters to the Philadelphia branch office of the Ball engine company, for various electric light plants.

The Gould and Watson Co., of Boston, report that business this season is six weeks in advance of any heretofore. They have recently received some very large orders for insulators, and their factory is taxed to its utmost to get out the goods. They have just come into possession of one of their bell form of moulded mica line insulators which had been removed to make change in construction of line, from the overhead system of the West End Street Railway Company of Boston. This bell has been hanging for 2 years and 10 months, and was found on close examination to be as sound as ever, with no signs of disintegration. This particular insulator has been well tested in its position repeatedly and never showed any leakage.

The Standard Electric Co. of Vermont, have recently sold a 500 light and a 300 light dynamo to the Quincy Market Cold Storage Co. of Boston, and a 500 light dynamo to Messrs. Callender, McAustan and Troup, Providence, R. I. Their western agents, the Electrical Engineering Co., of Chicago, have just sold a 500 light dynamo to Underwood & Company, of Chicago.

WESTERN TRADE NOTES.

George Cutter, the electric specialist of the West, has just returned from a trip to Boston, where he arranged to act as Western agent for the Pettingell-Andrews Co. He will carry a full line of their K. W. cut-outs and rosettes, and also a good assortment of magnet wires. He has already received over six thousand of the incandescent lamps made by the Germania Electric Co., with which he expects to throw a light on his other good things.

Mr. C. B. Coon, the well known Chicago manager of the Hill Clutch Works, has just closed a large contract with the Valley City Street Railway Co., for the whole power transmission outfit, shafting, pulleys, rope sheaves, &c. The competition was keen, but Mr. Coon carried off the honors in spite of everything.

Wm. Baragwanath & Son, of West Division street, Chicago, are having built by the Hilles & Jones Co., some of their latest pattern heavy punching and shearing machines. They were compelled to contract for this machinery not only by the increase in their business, but by the general tendency to heavier and larger heaters in electrical and other branches. Where a few years since a 500 horse power heater was considered large, 800 to 1,500 are quite common now, and one turned out by the firm last year will heat to 216° F. the feed-water for 2,200 h. p. boilers.

Mr. Charles Jaeger, the manufacturer of mercury pumps for incandescent lamp work and delicate and intricate glass apparatus has removed from 200 E. Kinzie street, Chicago, to 48 Sand street, Brooklyn, N. Y.

Mr. Thomas G. Grier, managing engineer of the National Engineering Bureau, has recently been engaged in making investigations and tests of the various commercial incandescent lamps. He has made a study of this question and is well versed in lamp testing.

Mr. Geo. Cutter, the "electrical specialist" of the West, has recently issued a "novel" containing nine chapters of thrilling interest, which he, with true Western modesty, terms a "Folder," because it doubles you up. The peculiar feature of the production is that it reads backward and is, therefore, not in keeping with the progressiveness of Mr. Cutter. Among other interesting topics it deals with medicinal laboratory tests of Simplex wire, and in this connection we would suggest that the chloroform employed be administered to the trees along the circuit instead of to "Simplex," which has the reputation of amputating their limbs and being a mighty good "tree-cutter."

Mr. T. L. Townsend, representing the Partrick & Carter Co., is now in New Orleans and reports that the Partrick & Carter goods are very popular in the South. Mr. Townsend will come North via Memphis and St. Louis, ending his present trip in Canada about the middle of May.

NEW YORK TRADE NOTES.

The New Process Rawhide Co. was represented in town last week by Mr. T. W. Meachem, its president, who reports business very active, indeed, with every sign of its continuance. The demand is not only active for their electric railway rawhide gears but for their rawhide bound mallets, chisel-handles and other excellent specialties. Their gears are also now finding their way freely into machine shops.

The Werline Mfg. Co., of York, Pa., have just started up their foundry department and are now prepared to furnish tempered copper commutator bars and electrical castings of all kinds to the trade. The progress thus far made by this company is indicative of a brisk and successful business.

Mr. H. D. Wheatcroft, of the Independent Bung Co., of this city, left last week for Elizabeth, Wirt county, Va., where their mills are located, to make arrangements for the enlargement of their facilities for turning out electric light moldings, and also to make the final arrangements for making wooden cleats of all kinds and sizes, this being a new branch which has lately been added to their business.

The American Electric Exercise Machine Co., now located at 280 Broadway, this city, are making arrangements to move farther uptown. They will probably locate on 14th street, and take possession by the first of May.

The East River Lead Works, 523 east 19th street, this city make strip solder for electrical purposes, and the quantities which they sell to this industry is already enormous. They are supplying some of the largest concerns in the country.

The McCreary Electrical Specialty Co. of 18 Cortlandt street, this city, have completed arrangements whereby they are going to introduce the Almond Fexible bracket to the electrical trade, and have already secured numerous orders for this novelty. Their excellent small cut-out, which was described in The Electrical Engineer of Feb. 25th (in which their name was omitted in connection with it) is filling a long felt want, and their orders for it are becoming more numerous every day.

ST. LOUIS TRADE NOTES.

The St. Louis Car Company.—During the past five months, this company have built 318 cars, nearly all of which were for electric roads. With the additional buildings and machinery erected last year they now have a capacity for an output of 60 complete cars per month, but are compelled to work three hours overtime daily to keep pace with time orders. Their new combination elliptic and coil spring electric motor truck has been placed before their patrons and is meeting with excellent success wherever used. They have just finished 50 electric motor cars for the Davenport-Moline Railway Co. These cars are 16 feet long, elegantly upholstered seats and backs and finished in cherry and mahogany, with all modern improvements. They are now engaged on the following orders; 15 motor cars and 15 trail cars, for San Antonio, Texas; 25 34 ft. double truck cars for the Union Depot Railway Co., St. Louis; 6 motor cars and 6 trail cars for Windsor, Sandwich & Amherst Electric Railway Co.; 4 open motor cars for the Richmond City R. R. Co.; 2 motor cars for the Ft. Scott Rapid Transit Co.; 9 16 ft. cars for the Memphis Consolidated Street Railway Co.; 2 open motor cars for the National Electric Tramway and Lighting Co., Victoria, B. C.; 5 double truck 20 ft. motor cars for the Great Salt Lake and Hot Springs R. R. Co.; and 5 motor cars for the Davenport Central Railway Co.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. APRIL 22, 1891. No. 155.

THE DELANY CIRCUIT TRANSFER SYSTEM.

BY

Patrick B. Delany

THIS system has been designed to meet a comparatively new but promising demand for the use of private telephone and telegraph facilities, by subscribers whose business with their correspondents at distant points will not warrant the expense of a wire for their own use exclusively. The new system transfers a wire simultaneously at both ends from one pair of subscribers to another every five minutes, if desired.

It will be seen, in the accompanying diagram, that in the segment circles over which the trailing fingers travel, there are twelve segments, and reference to the controlling clocks, the trailing arms of which are mounted on the minute hand shafts, will show that the local circuits of the polarized switches are reversed at the end of each five minutes in the hour; therefore, the line is transferred from one segment to another every five minutes, and the apportionment of time among subscribers depends upon the disposal of the segments in the path of the trailing fingers.

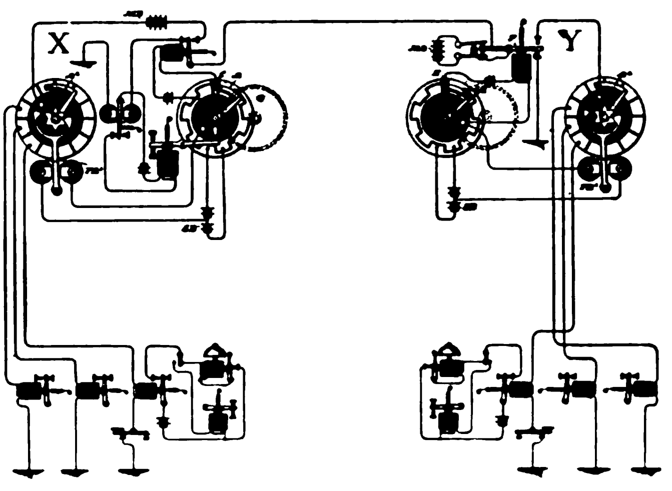
If a subscriber and his correspondent are connected to one segment they can communicate for five minutes each hour, paying the minimum fixed yearly rental for these facilities. Should they find that their business required ten minutes each hour, they could be connected to two adjoining segments, or, if preferred, to one segment on each side of the circle, which would enable them to communicate for five minutes every half hour. Other subscribers would have the line for whatever portion of time they arranged for, the object being to accommodate subscribers with whatever facilities they choose to pay for.

This class of business has not been encouraged to any great extent heretofore, because of the trouble and expense of making the transfer with uniformity and precision by hand. Now that the work may be done automatically, and with unerring reliability, there is no reason why a large subscriber business should not be secured, and at rates of rental which would, in the aggregate, amount to double the return from a wire rented exclusively to one party without making the rates to the individual subscriber burdensome. An important advantage of the system is the futility of the subscriber's disposition to cajole the switch into allowing him to have the circuit "just half a second longer." When his time is up he is unceremoniously cut off until the line comes round again. The arrival of the line is announced by an alarm bell, and the subscriber, knowing the arbitrary and unfeeling character of the automatic switchman, will naturally make the best use of his time.

The system covers several modifications of the plan shown in the illustration, which, however, is the preferred one, as the line circuit is not made up through any moving contacts, these being confined to the local circuits. The line contacts are always at rest, except at the instant of transfer, and are as perfect as though they were made through the ordinary switch.

The apparatus is regulated automatically every hour. If the clock at X gains or loses, not exceeding half a minute in the hour, an impulse will be sent from Y which will correct it, so that both clocks start off exactly on the second at the beginning of each hour. In practice, two ordinary clock movements will not vary more than a few seconds in an hour. By winding the clocks once a week, the switching system goes on night and day, requiring no further attention.

The connections in the diagram are interesting and easily followed. The main line is to earth at each end through the instrument of one subscriber or another. Main batteries M B are located at the central offices and looped into the line. Normally, the negative pole is to line at Y, and the positive pole at X. The drawing shows the apparatus setting itself at the end of the hour. The trailer, A at Y is on the thin blade E, which closes the local circuit of the pole changer F, the armature lever of which puts the positive pole of main battery M B to line. The trailer A^1 at X is on the small segment C which completes the local circuit of a neutral relay, the armature of which is connected to the line. When this armature lever goes to its front post the line is put to the polarized relay under it, and thence to earth. The tongue of this polarized relay is biased by a spring, but this bias is overcome by the positive current from Y, and the tongue is thrown to its left hand stop, where it closes the local circuit of the setting magnet. On the end of the armature lever of this magnet is a wedge-shaped piece which fits into the notch of the arm which forms a part of the trailing finger arm, and if the finger be fast or slow within the range of the relationship between the wedge and the notch, it will be set exactly at unison with the trailer A at Y. When this latter trailer passes off of the thin blade which represents three or four seconds, the local circuit of the pole changer is broken, the main battery is restored to its usual position, and the tongue of the polarized relay at X is drawn to its right hand stop by the spring, thus breaking the local circuit of the setting



THE DELANY CIRCUIT TRANSFER SYSTEM.

magnet, and releasing the trailing finger A. When this finger passes off of segment C, which takes thirty seconds, the local of the neutral relay is broken, the lever is drawn to its back stop, and the line connected to trailing finger A^1 at X, and to the subscriber connected to the first right hand segment at the top of the circle.

Two plates, each with six teeth lie in the path of the clock trailers A at X and A at Y. These plates are connected with the positive and negative poles of split local batteries S B so that when the trailing fingers pass from one segment or tooth to another, the local batteries S B are reversed and the tongues of polarized switches P R^1 are moved from one side of the trailing fingers A^1 A^1, which connected the line to the subscribers instruments, are moved from one segment to another every five minutes. One pair of subscribers is represented by a Morse outfit of relay, sounder and key—and an alarm bell. Normally the bell is switched into the local circuit of the sounder, so that when the line reaches the segment to which the subscriber is connected, the relay closes the bell circuit and notifies the subscriber that he has the line.

No temporary interruption to the line can disarrange the transferring apparatus. Should the line be broken, grounded or crossed, the clocks would go on, and the switches be operated just the same.

THE COLLINS DYNAMO.

The tendency in modern dynamo construction is decidedly towards a simplification of parts in the armature and field magnets. In the construction of alternating and multipolar continuous current machines especially, efforts are being made to reduce the energizing field magnets to their simplest form, and to dispense with a multiplicity of energizing coils. To that end recent constructors have adopted designs embodying a single magnet coil, energizing a number of pole pieces. The most recent form of this type is that due to Mr. W. Forman Collins, of Chicago, whose method will be readily understood from the accompanying engravings. As will be seen, the field magnet is confined entirely inside of a Gramme ring armature and consists of a single coil wound on a spool, the pole-pieces of which are extended radially across the head, and then again extended to form the working-poles which stand parallel to the axis of, and embracing the spool. In the multipolar machine the working-poles alternate with one another, forming a kind of cage, within which the spool is confined.

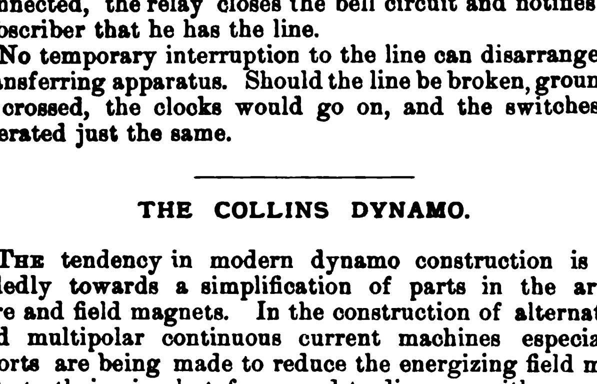
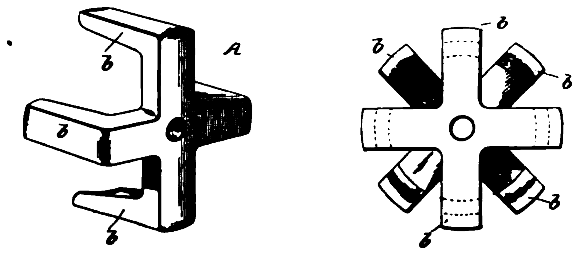


Fig. 1.—The Collins Dynamo.

In the engravings, Fig. 2, shows one set of the pole-pieces of an eight-pole machine, and Fig. 3 the two sets of the pole-pieces together. The field magnet is composed of a core *a*, Fig. 1, wound with a single coil, and the extending pole-pieces, as shown.

In Fig. 1 the field magnet is shown keyed to the shaft, and, in consequence, rotates with it. The armature remains stationary, being maintained so by the spider C, which is fixed to one of the pillow-blocks. The commutator is loose upon the shaft, while the brush-holder is fixed upon the shaft so as to rotate with it. If the armature is to revolve, the spider is made separate from the pillow-block and connected to the shaft by a key (shown in dotted lines in Fig. 1); the opening through the core of the magnet is made large enough to allow the shaft to rotate freely, and the magnet is supported by making it a part of the frame of the machine.



Figs. 2 and 3.—Field Magnets of Collins Dynamo.

This form of field magnet may be used on the alternating current machine, in which case the number of pole-pieces is increased.

THE FLOW OF CURRENT THROUGH AN ELECTRIC ARC.

In a recent number of the *Repertorium der Physik* there is a paper by H. Luggin, which contains a minute descrip- of experiments made to determine the laws which govern the flow of current across an electric arc between carbon points. Referring to the anode, Luggin distinguishes two kinds of discharges, the one taking place from the crater with considerable current density, and the other from the surrounding rim with a smaller current density, and at lower temperature. The vertical variation of potential was investigated by means of test pencils inserted at different points. When the point of the test pencil (a carbon rod 1.3 millimetre diameter) was placed well within the crater, the mean potential difference between the luminous surface of the anode and the layer of hot gases immediately contiguous to it was found from a mean of five observations to be 33.7 volts. The corresponding value at the cathode was found from six observations as 8.78 volts, whereas Uppenborn had previously determined the potential differences as 32.5 and 5.2 volts. According to the author's estimate, that part of the potential differences between the electrodes, which is caused by the transition from the solid to the gaseous conductor, and is therefore independent of the length of arc, amounts to 42.5 volts, which is the sum of the values above given. The experiments were made with currents up to 20 amperes, and electrodes of sufficient size in each case to prevent the arc from hissing. A series of experiments was made to determine the hissing point, which the author found is reached when the current density exceeds about ½ ampere per square millimetre (3.23 amperes per square inch) of crater surface. For hissing arcs the potential difference between the anode surface and the layer of hot gases next to it is greater, but it does not increase in proportion with the current density, and it would therefore be incorrect to ascribe this potential difference to the existence of a constant resistance. Although this consideration would naturally lead to the assumption that the arc is the seat of a counter-electromotive force, the author has failed to detect the slightest polarization of the electrodes after the current was interrupted. By carefully contrived mechanism he was able to make connection between the electrodes and a delicate electrometer within the 0.005 part of a second after cutting off the current, and yet not a trace of charge could be detected in the electrometer needle. The author does not, therefore, believe it possible that the arc can be the seat of a counter-electromotive force of 40 volts, as suggested by Dub.

THE BUDA-PEST CONDUIT ELECTRIC RAILWAY.

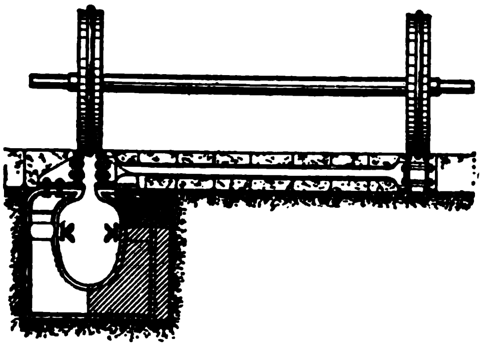


FIG. 1.—BUDA PEST ELECTRIC RAILWAY.

In a recent issue we made brief mention of the operation of the electric railway in Buda–Pest, in which a conduit system is employed and applied in a manner suggested some time ago in this country by Mr. Stephen D. Field. To the information already given we are able to add further details.[1]

As will be remembered, one of the wheels, Fig. 1, rests on a Haarmann rail, while the other rides upon the top of the conduit, which is built up of two angle irons, leaving a slot about 1⅝ inch wide. The conduit itself is oval in section, being about 11 inches wide and 13 inches deep. The cast iron frames to which the double rail is bolted are placed 48 inches apart. The conductors which are supported by insulators, consist of angle iron which has sufficient conductivity and is able to withstand the wear due to the friction of the contact plow. The motor employed, which is illustrated in Fig. 2, is constructed in a manner similar to the early Siemens dynamos with magnets of bar iron, which type was adopted in order to reduce as much as possible the weight of the machine. As will be noted, the motion is transmitted to the car axle through the medium of a sprocket chain. The E. M. F. employed is 300 volts.

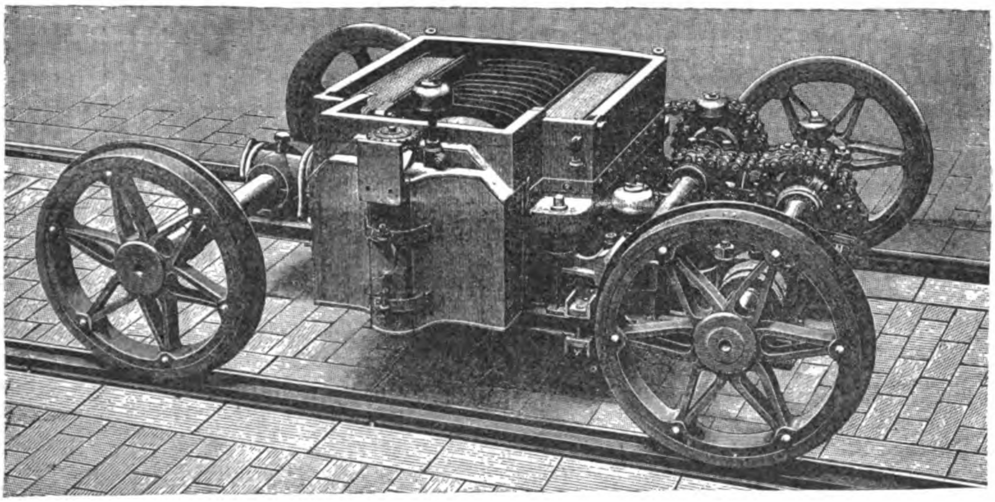


FIG. 2.—MOTOR TRUCK, BUDA PEST ELECTRIC RAILWAY.

At present there are three lines in operation in Buda-Pest, employing the conduit system; the first of these, started July 30, 1889, is a trifle over 1½ miles long, the heaviest grade is 15 per cent., and the sharpest curve has a radius of 155 feet. The second line is about 2¼ miles long, with the heaviest grade 16 per cent. combined with a curve of 140 feet radius. This line has been in operation since the 10th of September, 1889. The third line has been in operation since the 6th of March, 1890. In addition to these lines three more are in process of construction, and it is proposed to introduce the overhead system on at least one of them. During the operation of these roads the cars, up to the end of December, 1890, had covered 888,687 car kilometres, and carried 4,924,030 passengers, averaging 5$\frac{54}{100}$ passengers per car kilometre. The general speed of the cars within the city is limited to 9½ miles per hour, though beyond certain limits 11¼ miles is permitted; but in the narrower streets the speed is limited to 6, and at corners to 4 miles an hour. Each car makes 75 to 80 car miles per day of 16 hours.

THE ELECTRICAL PURIFICATION OF WINE.

FOR some time past, says *La Lumière Electrique*, M. de Meritens has been experimenting on the electrification of wine, and M. Martinotti on the application of electricity to vine diseases; and now F. Mengarini has just published a brochure extracted from the *Giornale delle Stagioni Sperimentali Agrari*, Vol. XVIII., entitled "The Reduction of Acetic Acid Present in Wine by Means of Nascent Hydrogen Generated by Electrolysis." If we take two jars filled with wine, connect them by a U tube filled with alcohol and divided at the middle by a parchment diaphragm, place platinum electrodes in the jars and pass a current, the acidity of the wine in the jar containing the kathode is diminished. It is this diminution of acidity due to hydrogenation that it has been sought to turn to practical account. The following are the results of some of the experiments. A 20.19 per cent. solution of acetic acid was converted into a 19.75 per cent. solution after four hours, and into a 16.72 per cent solution after 28 hours' electrolysis. Some sound red wine containing 7.208 per cent. of acid was exposed to the air for 24 hours, and turned sour when it contained 8.228 per cent. of acid. After eight hours of electrolysis the proportion of acid was reduced to 6.53 per cent. The current usually employed varied from 120 to 260 milliamperes, although currents of only 35 or 40 milliamperes were found to produce a beneficial effect. The apparatus intended for operations on a large scale is as follows:—A cylindrical vessel of 1 hectolitre (22 gallons) capacity, of enamelled earthenware, at the bottom of which rests a disc of compressed carbon 12 inches in diameter, which communicates with the negative pole by means of a carbon rod about ½ inch in diameter, encased in a glass tube containing paraffin. In the neck of the vessel slides a small earthenware cylinder, closed at the bottom by a sheet of parchment, on which rests a slab of carbon. The wine to be treated is poured into the larger vessel, the upper small cylinder containing alcohol and water.

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[1] *Elektrotechnische Zeitschrift*, April 3, 1891.

EFFICIENCY TESTS.

BY

H. J. Williams

It is often desirable to obtain the efficiency of a dynamo or motor in cases where a suitable dynamometer for measuring the mechanical power is not available. That accurate results can be obtained, using only a voltmeter, ammeter and speed indicator, is well known to electrical engineers. But there are, doubtless, many to whom the problem seems difficult, if not impossible, and to them this article is addressed. The motor used in the following tests was of the consequent pole type, shunt wound for a potential of 110 volts and was rated at 3 h. p.

The method followed in calculating the efficiency is to measure the electrical energy absorbed by the motor, and subtracting the energy lost in the motor, to obtain the power available at the pulley. In a dynamo this loss should be added to the electrical energy developed in order to arrive at the power applied to the pulley. This loss consists of the wire loss in the armature and field coils, and the loss due to Foucault currents, hysteresis, and friction of the bearings, brushes, etc., to which must be added the loss of power in the rheostat, if the machine is running as a dynamo.

The wire loss is the product of the resistance by the square of the current flowing. Where the resistance is not known it may be computed by Ohm's law. Passing a current through the resistance, and measuring both the current and the drop of potential, we have at once, resistance equal potential, divided by current. In obtaining the armature resistances, we measure the current flowing through the armature, and the potential at the brushes. In this case, however, the armature must be fastened, so that it cannot revolve, or an error due to counter-electromotive force will be introduced.

We have now to account for loss due to Foucault currents, hysteresis and friction. These losses are generally considered together, although they could, if necessary, be separated. Once obtained, they may be considered practically constant for the same speed.

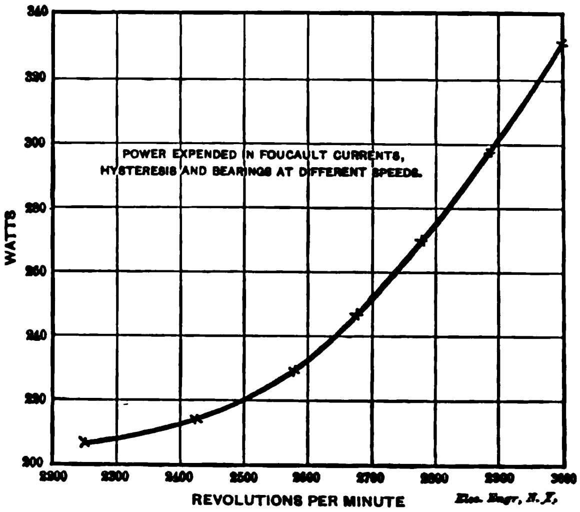
If now the belt is removed from the pulley, the motor is doing no work, and all the energy consumed is expended in wire loss and Foucault currents, hysteresis and friction. The wire loss is quickly calculated from the resistances and currents in the different parts, and the remainder charged to Foucault currents, hysteresis and friction.

Let us take an actual example. The potential at the mains is 112 volts; the total current flowing, with the belt removed, is 29 amperes; this gives us a total loss equal to 112 × 2.9 = 324.8 watts; the potential difference at the rheostat in the field circuit, 12.5 volts; the potential difference at the field terminals, 99.5 volts; speed, 2,250 rev. per min. By the method previously mentioned the resistance of the field was found to be 95 ohms, and that of the armature .29 ohm. The field current is $\frac{99.5}{95}$ = 1.047 ampere, and the loss in the field wire is 104.18 watts. As the rheostat is in series with the field, it has the same current, and the loss here is 13.09 watts. The armature current is 2.9 — 1.047 = 1.853 ampere, and the loss in the armature wire is .986 watt; making altogether 118.256 watts.

Now the total loss was 324.8 watts; having accounted for 118.256 watts as wire loss, the remaining 206.54 watts must be due to Foucault currents, hysteresis and friction. The resistance in the field circuit should be varied, and the loss due to Foucault currents, hysteresis and friction determined for each speed. The accompanying curve is thus plotted, showing the relation between these losses and the speeds at which they occur.

The belt was then replaced, and the motor loaded and the following readings taken: potential at mains, 112 volts; drop over field, 82 volts; main current, 25.3 amperes; speed, 2,500 rev. per min. The rheostat had not been removed from the field circuit when these readings were taken.

Now the field current is $\frac{82}{95}$ = .863 ampere, and the wire loss in the field is 70.77 watts. The drop over the rheostat must be 20 volts, and the loss here is therefore 17.26 watts. The armature current is 25.3 — .863 = 24.437 amperes, and the wire loss in the armature 59.55 watts. Looking at the curve we find the loss due to Foucault currents, hysteresis and friction for 2,510 rev. per min. is 220 watts. Adding these losses we have a total loss of 367.62 watts. The total power absorbed is 2,833.6 watts, giving 2,465.98 watts available at the pulley, or an efficiency of 87 per cent.



Curve of Efficiency at Various Speeds and Loads.

This method may also be applied to transformers, in which case the total loss consists of wire loss and loss due to Foucault currents and hysteresis, and the curve is plotted for the relation between the potential and the loss due to Foucault currents and hysteresis.

A WIRE-BOUND GODDESS OF LIBERTY.

During a performance in Laurenceburg, Ind., recently, in which the various industries of the town were represented by girls dressed in appropriate costume, the superintendent of the electric station produced a very pretty and novel effect. A young girl, dressed in white and the national colors, was wrapped in a network of wires, invisible from the audience, and twenty-five incandescent lamps were fastened in her dress and hair. One lamp rested on her head, and one was held in her hand as she stood in the attitude of the statue of Liberty. The house was darkened and the current turned on suddenly, producing a startling and beautiful tableau.

CENTRAL STATION MANAGEMENT AND FINANCE.—I.

(*Copyright, The Electrical Engineer.*)

BY

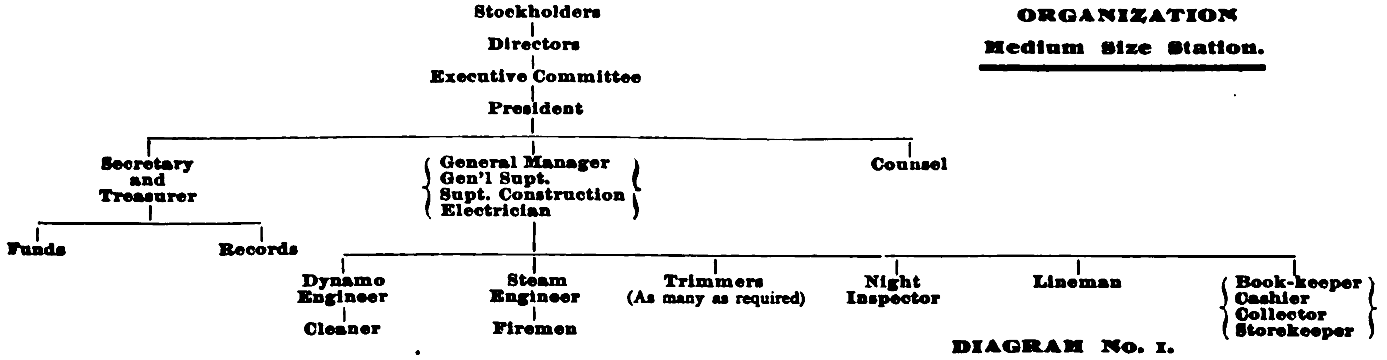
Horatio A. Foster

In the earlier days of electric lighting when prices ranged all the way from 70c. to $1.00 per arc lamp per night, and the incandescent lamp had but just started, central stations, which under ordinarily good management should have returned very large profits, were run in a most lavish manner as to expense, and too often on the contrary proved rank failures. This too, with machinery which has no very decided improvement to-day, and almost no change in the lamps used.

The central station business was so new that very few well established business men could be persuaded to take hold of its management, and it gradually fell into the hands of younger untried men, who too often were more prone to experiment with the business than to spend the necessary time in organizing it thoroughly on an economical basis. Again, the majority of those so placed had not the previous business experience to understand fully the necessity of systematic organization and strict discipline.

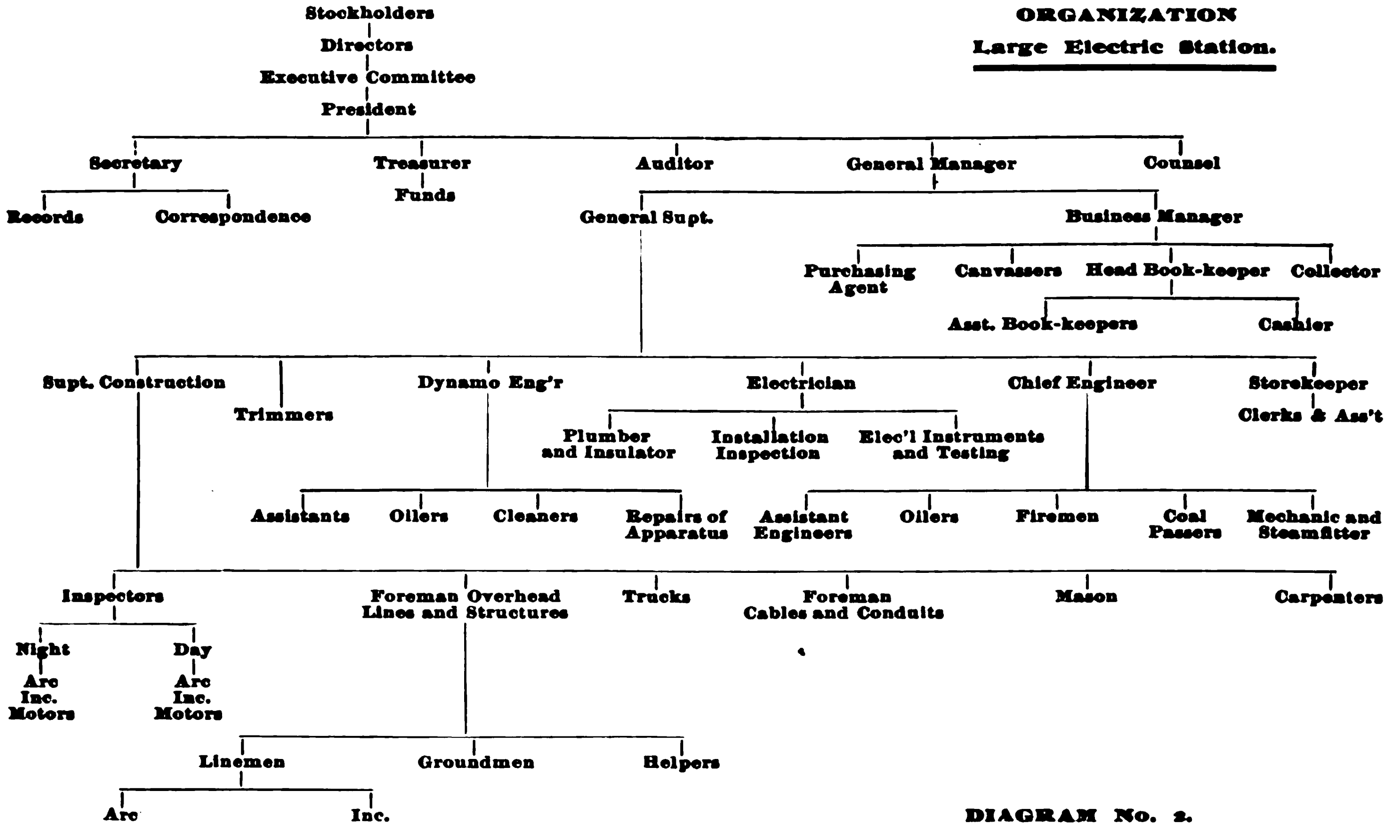
In the matter of labor, the various departments had not been gauged so as to determine what was a fair day's work and what would be the proper number of employees. Take the matter of carbon trimming alone; it was not so long ago that 40 lamps per day was considered the proper number for a man to clean and trim, when at the present time from 70 to 90 is considered a fair average; and in some places 100 is the standard, and stations have been known where 120 per man were crowded on. Other departments were similarly crowded, and many times men, recommended by some friendly official who had been influential in helping through city contracts, were given places when they were not needed. This, added to the extreme tenderness of the dynamo machine as then constructed, all helped to try the patience of the capitalist.

At the present time when prices have been pushed down to bed-rock by economically inclined Mayors and city officials, and sharp competition has set in, it is necessary to practice all the small economies which can only come from careful organization and strict discipline, and a most care.



ORGANIZATION
Medium Size Station.

DIAGRAM No. 1.



ORGANIZATION
Large Electric Station.

DIAGRAM No. 2.

Plans of Organization for Electric Light Stations.

ful system of accounts, both of financial and operating departments. To that end, the writer, together with the editors of this paper, has endeavored to outline a complete system of reports which shall embody all the points necessary to be kept in sight in order to show at any time the exact condition of any department, and, by recapitulation, to indicate the state of the business at regular periods, both financially and as to efficiency of operation.

The style of station taken as an example will be of that very large class which started originally with a small plant of arc lamps and gradually developed into large combined arc, incandescent and power stations. Circumstances will often govern the special method of organization; but the following has been found to meet the general requirements. For stations of the medium size, say 200 arcs and 1500 incandescents, Diagram No. 1. indicates a good scheme of organization. Larger stations, say from 600 to 2,000 arcs with from 5,000 to 20,000 incandescents would be better organized upon the plan of Diagram No. 2.

The organization naturally divides itself into the station or operating department, and office or financial department. As the latter is not materially different from any other counting room system we shall treat it with rather short mention, and that only at the end of the article.

All stations should be provided first, with a comfortable office for the officials, who necessarily have to be close at hand; and no man can be expected to make anything like accurate written reports without some place to do his writing. This should be provided for him in some convenient spot, generally under the eye of the superintendent or general foreman.

The next, and in the writer's opinion, the most important thing in the economy of the central station, is a well-constructed store-room, where everything of a portable nature, from office pens to cylinder oil, must be kept under lock and key, and only surrendered in quantities required by written orders from a foreman. The blanks necessary for use by the storekeeper will be referred to under the proper head.

Rule No. 1 and the most important regulation of all for the general superintendent, or any general foreman, is that no order for work of any nature be given other than in writing; this will be found to relieve all hands of responsibility by reason of bad memories, or otherwise; keeps a record of the time the order was given and finished, and the cost of executing the same. Blank No. 1, shown here slightly reduced, is a form which has been found to answer this purpose very well, and should be put up for use in books of 100 or 200 leaves.

The order number at the top must be placed on all requisitions for material from the store-room, and on all labor tickets used on the work indicated. When the job is finished and the slip is returned to the office, the value of all material recorded on the back, and of the labor shown on the labor tickets handed in under that order number, can be calculated and written in, and thus the cost of that particular job referred to at any time.

Where a system of this kind is adopted it is well to issue a few general orders, which should be framed or fastened permanently to some convenient bulletin and kept always in sight.

The orders would read somewhat as follows:

ORDER No. 1.

Issued.

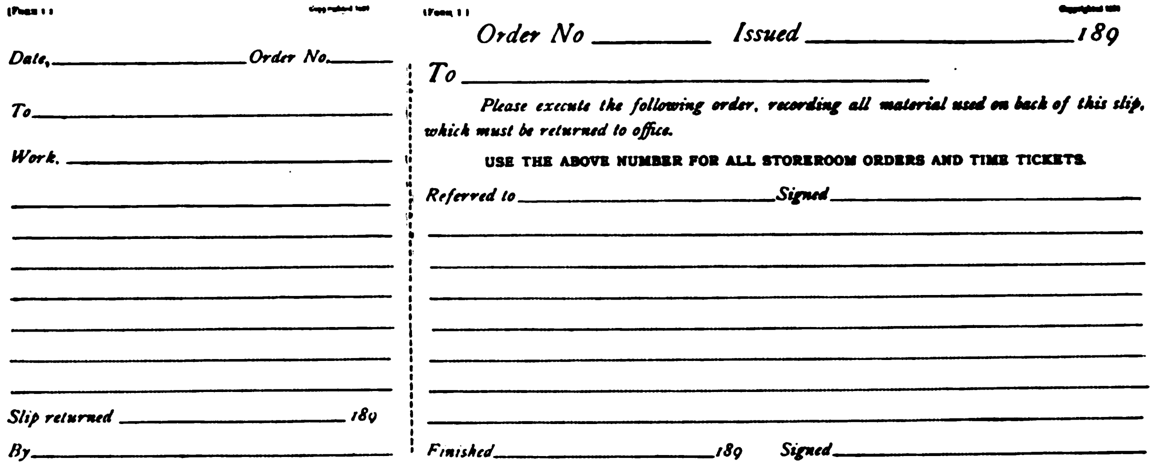
Signed.

All firemen or employees in the boiler room will put the above order number on their time tickets and store-room orders.

ORDER No. 2.

Signed.

All engineers or employees in the engine room will put the above order number on their time tickets and store-room orders.



Date, ______ *Order No.* ______

To ______

Work. ______

Slip returned ______ *189*

By ______

Order No ______ *Issued* ______ *189*

To ______

Please execute the following order, recording all material used on back of this slip, which must be returned to office.

USE THE ABOVE NUMBER FOR ALL STOREROOM ORDERS AND TIME TICKETS.

Referred to ______ *Signed* ______

Finished ______ *189* *Signed* ______

BLANK FORM OF DEPARTMENTAL ORDER.

And so on about as follows:

ORDER No. 3.

For Dynamo Room.

ORDER No. 4.

For Offices.

ORDER No. 5.

Repairs in Boiler Room.

ORDER No. 6.

Repairs on Engines.

ORDER No. 7.

Repairs on Electrical Apparatus.

ORDER No. 8.

Repairs on Pole Lines.

ORDER No. 9.

Repairs on Stations.

ORDER No. 10.

Repairs on Inside Wiring.

If motor work is done, or street car lines are run, additional orders can be issued to cover those departments.

In smaller stations it is perhaps unnecessary to make more than one order for general operating and one more for general repairs, although it is very convenient to know where the repairs were. Such orders will apply to all on the operating pay roll.

THE ACTION OF ELECTRIC CURRENTS ON THE HUMAN EYE.[1]

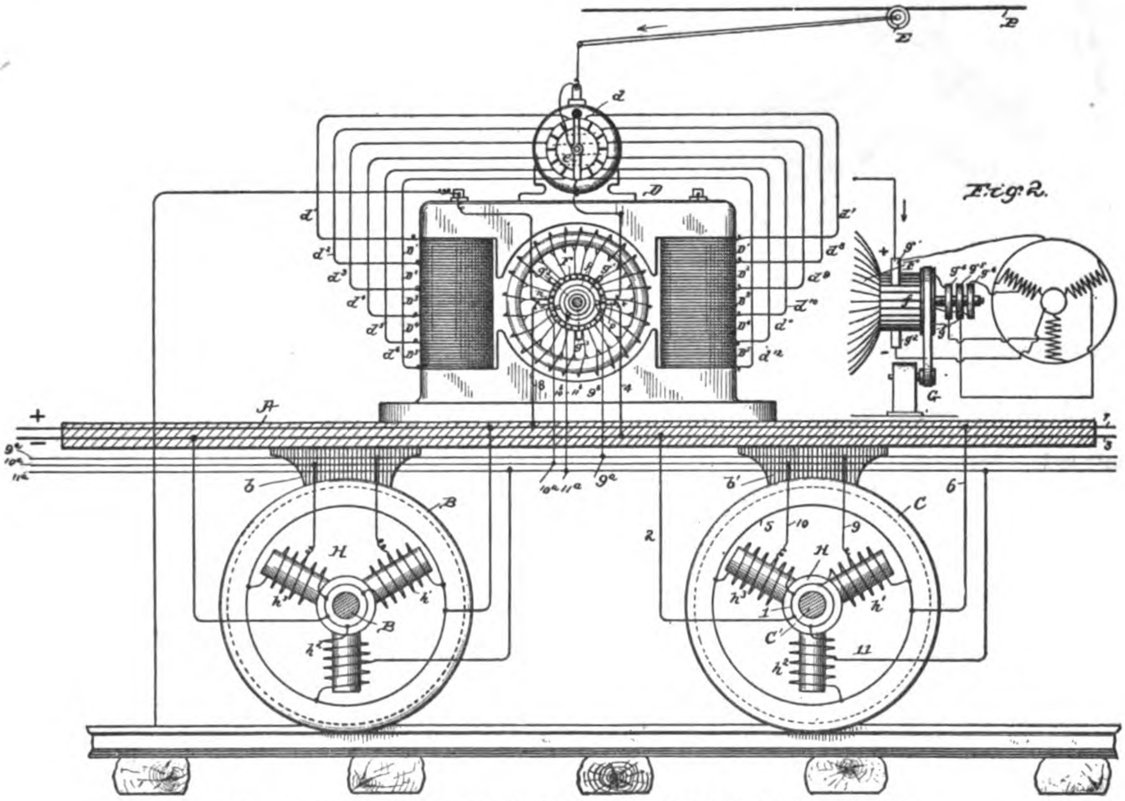
Prof. Dubois, of Berne, has been lately studying the physiological action of electric currents and discharges, and he has some interesting observations on the human eye, which, it is known, has luminous sensations under the action of galvanic currents. Sudden variations of current strength, especially at making and breaking the circuit, produce flashes. With a moistened plate at the nape of the neck, and a pad on the eye, a slight flash was distinctly perceived even with a Leclanché cell, giving about 1.20 volt and .04 milliampere. Raising the current to .5 milliampere, the observer could tell which pole was applied to the eye. On the other hand, the retina responds much less readily to discharges from condensers or induction coils. Not till a capacity of 0.037 microfarad and a pressure of 21 volts was reached, was a true retinal flash perceived; and not even with 10 microfarads were the durable sensations characteristic of the two poles produced.

VAN DEPOELE'S RECIPROCATING ELECTRIC RAILWAY MOTOR.

Our readers will remember the description of an electric power hammer in The Electrical Engineer of September 17, 1890, invented by Mr. Charles J. Van Depoele, of Lynn, Mass. The same reciprocating action of the bar of iron sliding in the solenoid, in connection with a current distributor has recently been applied by Mr. Van Depoele to motors for railway service. As will be seen in the accompanying engravings, Figs. 1 and 2, the machine is provided with sectional field magnet coils D^1, D^2, etc., connected by conductors d^1, d^2, etc., with separate sections of the commutator-switch d. This switch has a movable contact e, electrically connected through E with the conductor P. In addition to the main commutator brushes, P N, three equidistant brushes, g^1 g^2 g^3, are rotated about the periphery of the commutator by the small motor G. The speed of this motor is independently controlled, so that the rate of rotation of the brushes may be regulated as desired. In order to collect the current from these brushes, three insulated contact surfaces, g^4 g^5 g^6, are carried upon a sleeve on the armature shaft.

Upon the axles B′ C′ is mounted a triple reciprocating electric motor H, the magnetic pistons of which, moving within the actuating-coils are all three connected to a crank upon the axle by which the motors are carried.

Each one of the coils is in the form of a double solenoid, all the inner terminals of which are connected to a supply-conductor 1, connected to the positive brush of the machine by conductors, all the outer terminals of the coils being connected to a common return-conductor 5. This is connected to the negative brush of the machine and thence to the return conductor through conductors 6, 7, 8. The solenoids are therefore in multiple arc between the main brushes of the machine. The current is caused to rise and fall alternately in the motor engine coils by means of the triple moving brushes, one of which is electrically connected midway of each of the solenoids h^1 h^2 h^3 through conductors 9, 10, 11, which are connected with contacts engag-



Figs. 1 and 2.—Van Depoele's Reciprocating Railway Motor.

A FRENCH ELECTRICAL MINING PLANT.

The Compagnie Continentale Edison installed an electric haulage plant last year in the Mines de Marles, and it has given such satisfaction that the original plant is now about to be considerably enlarged. The generator is a 26 unit Edison machine, giving 400 volts at 900 revolutions. The pit is nearly 1,000 feet deep, and the line runs along a gallery 1¼ miles in length. The locomotive is 7ft. 8 in. long, 2 ft. 4 in. broad, 4 ft. 11 in. high, and weighs 2 tons, 6 cwt. The motor, a 10 unit machine, is arranged lengthwise and drives on to both axles through double helicoidal gearing. A speed of over 9 miles an hour is attained, and 10 b. h. p. is developed when hauling a train of 25 fully loaded skips, each weighing 14 cwt. The conductors in the gallery are two Vignole rails suspended from porcelain insulators fixed in the roof, and the current is taken off by traveling carriages fitted with brushes and connected to the locomotive by flexible conductors. The plant efficiency is stated to be 75 per cent.

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[1] *Nature.*

ing the surfaces g^4 g^5 g^6. It follows, therefore, that as the three brushes g^1 g^2 g^3 and their contacts are moved about the commutator *f* they will successively approach and recede from the points of maximum and zero electromotive force, thereby causing a corresponding rise and fall of current in the motor coils of the triple engines in exact accordance with the movements of the brushes.

In Fig. 3 is shown a three-cylinder motor. The coils of the solenoids are inclosed in a continuous iron envelope *i*, which forms the outside casing and frame of the engine. Inside the coils k k^1 k^2 are placed diamagnetic tubes l l^1 l^2, which are securely fastened to the heavy rings O O^1 O^2 upon the outer ends of the cylinders, and to the casting D, which forms the central crank-chamber M, into which the plungers N N^1 N^2 are projected at the inner limit of their stroke. Upon the shaft S, is secured the crank K^3, upon the crank-pin of which are journaled the connecting-rods r r^1 r^2, which are pivoted to the plungers N N^1 N^2.

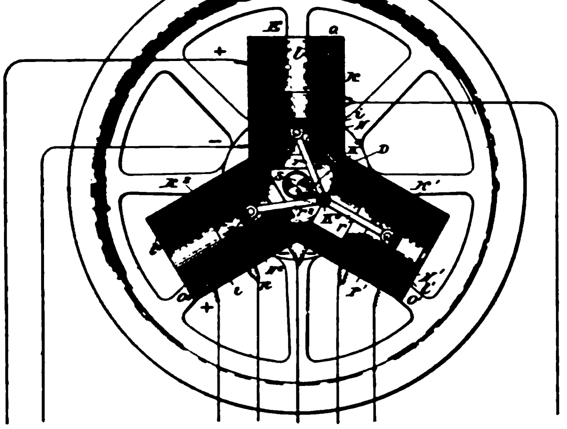

FIG. 3.—VAN DEPOELE'S RECIPROCATING RAILWAY MOTOR.

HYDROCHLORIC ACID IN BICHROMATE CELLS.

BY

Chas. Steinmetz.

WHEN small amounts of electric power are needed for closed-circuit work, as, for instance, for electro-plating, for medical use, etc., which cannot conveniently be derived from dynamos, the bichromate battery is generally called upon; that is, amalgamated zinc and carbon in a mixture of dilute sulphuric and chromic acid. This battery is used because it is simple and compact, combines high E. M. F. with low internal resistance, and has, for a single-liquid battery, a very low polarization.

Unfortunately, however, the usual bichromate cell has two great disadvantages. If too much sulphuric acid is used, then the internal resistance is low, and the E. M. F. high; but after a few minutes the liquid gets hot, begins to boil, the E. M. F. drops down, and, in spite of the best amalgamation, zinc and acid are consumed with frightful rapidity and the battery has to be taken apart at once. Or, if less sulphuric acid is used, crystals of the products of chemical action are formed on the zinc, the internal resistance increases greatly, and soon the current stops almost entirely.

A few days ago, in putting together my bichromate battery, I found myself short of sulphuric acid, and, remembering the suggestion made in one of the recent issues of THE ELECTRICAL ENGINEER, to use, instead of the usual compound, a mixture of bichromate, sulphuric acid and hydrochloric (muriatic) acid, I added a quantity of crude muriatic acid. The effect produced thereby seems to me remarkable enough to be of general interest. Only four cells were used, in multiple series. They were composed each of a thick arc-light carbon, and an amalgamated zinc rod of equal size. With a cold concentrated solution of bichromate of potash was mixed about as much sulphuric acid as necessary to set the chromic acid free, and then the rest of the hydrochloric acid added.

There were no instruments at hand to make exact readings; but from the work done by the battery I determined that, after over half a day's continuous use with a very low external resistance (cyanide of silver solution of large cross-section), neither the E. M. F. nor the internal resistance was perceptibly changed, and was about the same as in the ordinary bichromate cell with an equivalent surplus of sulphuric acid.

None of the four battery-cups got hot; neither could I perceive any boiling over, nor a formation of crystals on the zinc, but the battery ran steadily until the liquid showed the greenish-yellow color of approaching exhaustion. Only in one cup, where a smaller amount of hydrochloric acid was used, to see its effect, very few crystals were found on the zinc, but not enough to interfere with the working of the cell.

Therefore I can recommend all users of the bichromate cell to take only as much sulphuric acid as necessary for the dissociation of the bichromate of potash or bichromate of soda, and to add just about as much, or somewhat more, of hydrochloric acid. Even when the liquid shows signs of beginning exhaustion, it can be restored again, for a while. by a further addition of hydrochloric acid.

I need not remark that the name "chlorochromic acid" used in the notice referred to above, is wrong and misleading, because this chemical term means a chlorine-derivative of chromic acid, that is, the well-known chromyl-chloride, which is certainly not contained in the liquid, because it is dissociated by water into chromic acid and hydrochloric acid. The liquid contains nothing but a mixture of chromic, sulphuric and hydrochloric acid.

LAUNCH OF THE "ELECTRIC."

ON Tuesday, April 7, the electrically propelled pinnace "Electric" was launched from the Strand Electric Launch Works, Chiswick. This pinnace has been built by Messrs. Woodhouse and Rawson for the conveyance of troops between Her Majesty's dockyards at Chatham and Sheerness. The "Electric" has a tonnage of 4¾, is 48 ft. 6 in. long over all, by 8 ft. 9 in. beam, with an average draught of 2 ft. 3 in., her full complement being 40 fully-equipped soldiers. The battery consists of 70 Epstein cells, and the motor, which drives a two-bladed screw 22 in. in diameter, will develop 5½ b. h. p. at 750 revolutions. The anticipated speed is eight knots. It is the intention of the Royal Engineers to make some exhaustive trials with this type of boat.

FRANKFORT EXHIBITION.

IN order to show the application of electricity to aerial navigation, a captive balloon, capable of seating ten persons, will be exhibited by Captain Rodeck at the forthcoming Frankfort Exhibition. The pulley which controls the ascent and descent will be operated by an electric motor, and a telephone wire will enable conversation to be carried on between those in the balloon and the people at the starting point below. Experiments will be made with the view to the steering of the balloon by electricity, and in the filling of the balloon with electrically prepared water-gas. Messrs. Siemens and Halske will make the electrical apparatus.

PROFS. AYRTON AND PERRY'S STANDARD OF SELF INDUCTION.

As the intelligent study and design of apparatus involving the phenomena of self induction has proceeded, the necessity for some standard of self induction has become more and more apparent. This applies not only to dynamo electric apparatus such as alternating machines and converters or those employing pulsating continuous currents, but also that large class in which alternating or frequently interrupted currents of small volume are applied, such as are used in telephony and telegraphy.

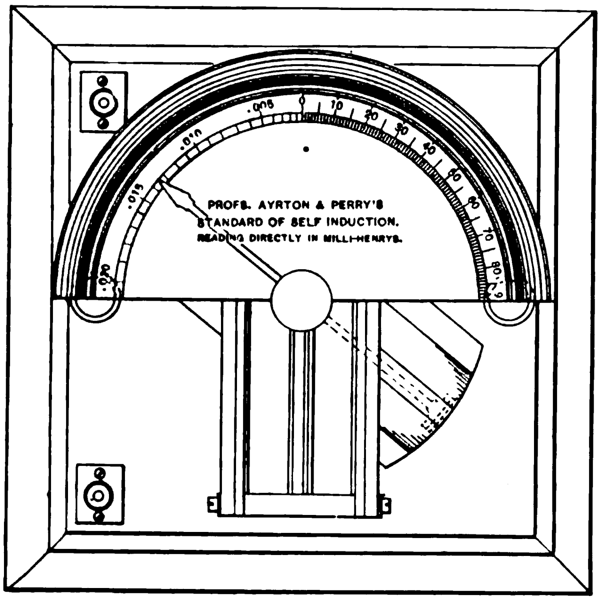

FIG. 1.—AYRTON AND PERRY'S STANDARD OF SELF INDUCTION.

It is evident that with some standard of self induction at hand, together with a secohmmeter and a Wheatstone bridge, the self induction of any apparatus can be quickly measured without much trouble or calculation.

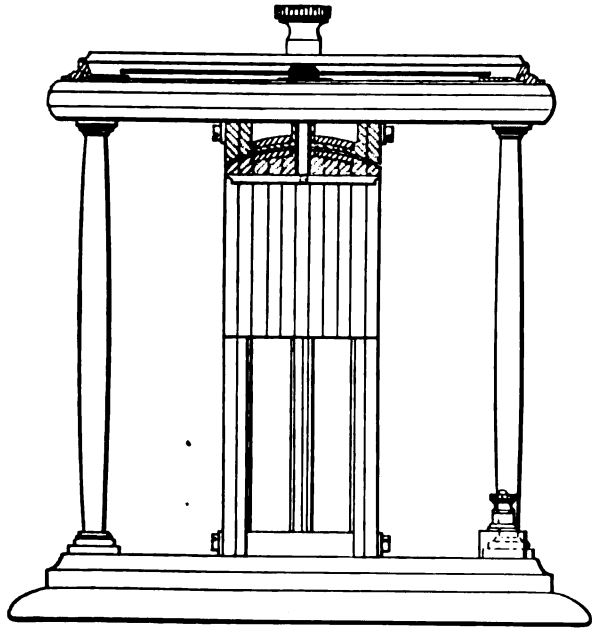

FIG. 2.—AYRTON AND PERRY'S STANDARD OF SELF INDUCTION.

Such a standard has been designed by Profs. Ayrton and Perry, and the instrument, as constructed by Messrs. Nalder Bros. & Co., of London, is shown in plan and side view in the accompanying engravings, Figs. 1 and 2.

The standard consists of three bobbins, two fixed and one movable, the latter so arranged as to be capable of moving through an angle of 180 degrees within the fixed ones. In order to get the maximum range and effect, the coils are wound upon a surface which is a zone of a sphere; this renders the use of two bobbins for the fixed coils a necessity. To get the maximum resistance to any change of form in the bobbins, they are built up most carefully with many pieces of the soundest Spanish mahogany.

This instrument in the stock form is wound so as to have self induction, varying from four millihenry's up to about thirty-six. The scale upon one side reads directly in millihenry's, and upon the other is provided with a degree scale, so as to be capable of use with a curve of calibration.

WIDTH OF SINGLE LEATHER BELTING.

BY

R. Grimshaw

THE following table, here published for the first time, gives the widths of 7/32 inch leather belting required to carry various horse powers at various speeds per minute; the belt being in good condition and wrapping half-way around cast iron pulleys, also in good condition. The tensions allowed for are such as to put no injurious strain on single leather lacings while permitting no slippage of the belt on the pulley.

The conditions and results are such as would be approved and desired by leather belting manufacturers for belts of their own make running in their own shops; in other words, where they wished, as consumers, to get the best life, drive, and money's worth out of the belts used.

WIDTHS OF SINGLE LEATHER BELT REQUIRED.

H.P.	Belt Speeds, Feet per Minute.								
	1,000	1,250	1,500	1,750	2,000	2,250	2,500	2,750	3,000
5	3.25	2.60	2.17	1.86	1.63	1.45	1.30	1.18	1.08
10	6.50	5.20	4.34	3.72	3.25	2.89	2.60	2.36	2.17
15	9.76	7.80	6.50	5.57	6.88	4.34	3.90	3.55	3.25
20	13.01	10.41	8.67	7.43	6.50	5.78	5.20	4.73	4.34
25	16.26	13.01	10.84	9.29	8.13	7.23	6.50	5.91	5.42
30	19.51	15.61	13.01	11.15	9.75	8.67	7.80	7.09	6.50
35	22.76	18.21	15.17	13.01	11.38	10.12	9.10	8.28	7.59
40	26.01	20.81	17.34	14.86	13.01	11.56	10.40	9.46	8.67
45	29.26	23.41	19.51	16.72	14.63	13.01	11.71	10.64	9.75
50	32.52	26.01	21.68	18.58	16.26	14.45	13.01	11.83	10.84
55	35.77	28.62	23.85	20.44	17.88	15.90	14.31	13.01	11.92
60	39.02	31.22	26.01	22.30	19.51	17.34	15.61	14.19	13.01
65	42.27	33.82	28.18	24.16	21.14	18.79	16.91	15.37	14.09
70	45.53	36.42	30.35	26.01	22.76	20.23	18.21	16.55	15.18
75	48.78	39.02	32.52	27.87	24.39	21.68	19.51	17.74	16.26
80	52.03	41.62	34.69	29.73	26.01	23.12	21.81	18.92	17.34
85	55.28	44.22	36.85	31.59	27.64	24.57	22.11	20.10	18.43
90	58.53	46.83	39.02	33.45	29.27	26.01	23.41	21.28	19.51
95	61.78	49.43	41.19	35.31	30.89	27.46	24.71	22.47	20.59
100	65.03	52.03	43.36	37.16	32.52	28.90	26.01	23.65	21.68

A NEAT TELEPHONE INDEX.

D. N. Coats, of Springfield, Mass., has just gotten up a device, that promises to be useful and not add to the vexations of telephone manipulations. The lists of subscribers are arranged in a portfolio which can be fixed against the wall, back of the instrument. A heavy cover holds the leaves in place, but can be dropped down or sprung back with a single movement of the hand. A metal guide slides along a bar across the top, controlling the indexed leaves. In looking for a telephone number one places the guide at the letter required, pulls down the cover and the leaves fall themselves, revealing the page wanted. The cover carries back the leaves automatically, when lifted, and holds them firmly in place once more. The index is made at the office of the Springfield Printing and Binding Company, and the pages can be renewed when enough numbers are changed to warrant printing a new list.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* The Electrical Engineer. *Communications for the attention of the editors should be addressed*, Editor of The Electrical Engineer, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

Vol. XI. NEW YORK, APRIL 22, 1891. No. 155.

The general mental qualification most necessary for scientific advancement is that which is usually denominated common sense.
—Joseph Henry.

THE MANAGEMENT OF CENTRAL STATIONS.

OCCASION was taken recently in these pages to review the report of the Massachusetts Gas and Electric Light Commissioners and to quote the statistics furnished therein as to the incomes and expenditures of the local companies. The information was not only valuable but much fuller than in any previous report, and we made, in passing, a mental note of the fact that the Commissioners made special reference to the great improvement in the methods adopted of keeping central station accounts. This improvement has kept step with that seen in central station construction, as evidenced by the valuable series of articles by Mr. A. C. Shaw that we have been publishing on modern New England stations.

It would, in truth, be difficult to dissociate the sound principles that apply to central station electrical engineering from those which apply to central station management and finance. A badly run station will owe its faults and failures to poor supervision and poor book-keeping in about equal proportion, while in a station that is properly conducted, the system of organization that is established in the dynamo room and engine room will run through to the last analysis of its accounts. It is needless to say that the hands of the superintendent and electrical engineer are immeasurably strengthened by the knowledge he enjoys of the manner in which his work is telling day by day in economy of operation and in the growing margin of profit.

With the object of assisting the many central station readers of The Electrical Engineer to a perfect plan of organization and a satisfactory basis of analysis and accounts, and carrying out a suggestion made to us some months ago by the president of a large parent company, we have begun in this issue a series of articles by Mr. Horatio A. Foster, who is well-known in electrical engineering and central station work, upon "Central Station Management and Finance." These articles will develop a practical plan applicable to the vast majority of stations in this country, and the advice and remarks of Mr. Foster will go to elucidate and explain many difficult points that come up in the conduct of a light and power plant. In order to make the plan adopted as simple and plain as possible, Mr. Foster has embodied in his text a large number of forms, blanks, sheets, registers, tickets, &c., such as are now actually in use by himself and others, and the regular employment of which adds so much to the efficiency and earning capacity of a plant. As to the advantages of each of these, Mr. Foster will have something pertinent and helpful to say, and we cannot but believe that the result of this endeavor will be seen in a higher standard of the art and industry.

WITH MORE ZEAL THAN DISCRETION.

An esteemed contemporary announces the discovery of three "weak points" in the patent laws of the United States. It has reached the conclusion that the establishment of "oppressive monopolies" under the protection of patents ought to be effectively prohibited; that the foreign inventor labors under almost insuperable disabilities in respect to the nature of proof required to establish his priority of invention in contested cases; and that patented inventions not put in public use within a reasonable time after the protection has been given, ought to be summarily deprived of it. We fear that the real source of our contemporary's disquietude is to be found in the fact that the American patent law has not been framed to meet the requirements of infringers. We may further remark that Congress appears to have no constitutional authority to change it to correspond more nearly to the views of this enterprising and industrious class of citizens. The Constitution of the United States, in express terms, empowers Congress "to promote the progress of science and the useful arts, by securing for limited times to authors and inventors, the exclusive right to their respective writings and discoveries." In view of the magnificent results achieved under its stimulus by the inventors of America, it is too late to question at this day, the wisdom of the fathers' provision; but whether wise or unwise, there it is, a part of our organic law, and likely to continue so. The patentee's right is *exclusive*, and though it may be limited in duration, it cannot be limited in scope. Congress has no power to step in between the patentee and his personal property, and undertake to dictate to him how, where and when he shall use it, or refrain from using it. We esteem it the one crowning merit of the American patent system, that the grant is unconditional and absolute, or without drawback or restriction in the nature of conditions subsequent. Two of our contemporary's points are therefore disposed by constitutional provision. As to the remaining one, it it is declared that while "it is already possible for American inventors to obtain valuable patent rights in foreign lands * * * * * * it is well-nigh impossible for a foreign inventor to secure a patent here if there can be found an American unscrupulous enough to claim the invention, naming a date prior to the foreigner's application in his own county." This is a gross mistatement of the provisions and practice of our patent law. Our rules of practice provide that he who, being an original inventor, first makes known to others within the realm (thus enabling its existence to be legally proven), the invention he has made, and perfects and seeks to patent the same with reasonable diligence, is entitled to the grant. It matters not in the least whether he be a foreigner or a native; the rule is the same. The benefit to the public, which is the consideration, and the sole consideration, for the grant, arises from the making known of the invention to the people of the United States. There is no conceivable reason why we should reward a foreigner, as of a matter of right, for something he has done in his own country and not elsewhere, unless he has, by publication or otherwise, constructively placed some person in this country in possession of a knowledge of it, and the very moment he has done this, he stands precisely on the same footing, in every particular, with his domestic competitor.

Suppose it is true that a certain proportion of the patents granted are never put to use. Suppose that some "successful" inventor has "found that progress along a certain line was barred by some old claim that has never been put to any service whatever, and neither benefits the public itself or permits any one else to do so." How large is the proportion? There are now in force about 300,000 patents. How many of these are obstructions in the way of progress because their owners will neither use nor permit them to be used? Not one-tenth of one per cent. Is it then worth while in attempting to guard against a limited and largely imaginary evil, not only to inflict incalculable injury and injustice upon the vast body of deserving inventors, but, by removing what is the principal incentive and stimulus to invention, the absolute security for a fixed term of years of patented property, to dry up, as it were, the spring of invention at its very source?

DELANY'S LINE TRANSFER SYSTEM.

ONE of the most noted developments of modern telegraphy is unquestionably that which is exhibited by the increase in the number of private lines that connect the offices of firms situated in different cities. These private lines, sometimes extending for hundreds, and even thousands of miles, have become a source of considerable income to the telegraph companies; and now the excellent work and service furnished by the Long Distance Telephone Company will, no doubt, see a large extension of this service, not only for telegraphic, but for telephonic purposes. The necessarily high cost of such a service makes it desirable to devise some means by which firms may enjoy its benefits without too serious a drain upon their resources, and hence a system by which the line can be "distributed" to a number of subscribers in succession during a fractional part of each hour must, we are convinced, prove of considerable value. It is true that this could be accomplished mechanically by an operator situated at the central office, but an automatic transfer of this nature will not only prove more economical to the company owning the lines, but will avoid all disputes as to time. Mr. P. B. Delany's system, which he describes in another column, seems well calculated to afford a proper system of transferring lines from one subscriber to another, and may, we hope, soon be seen applied in a practical way.

EFFICIENCY TESTS.

EVERY intelligent user of power is desirous of knowing the exact economy of the prime mover which drives his machinery. In the case of the steam engine, the indicator enables him to ascertain this point with tolerable accuracy and without any practical inconvenience. The user of electric power who is desirous of obtaining information as to the efficiency of his plant, and especially of the motor itself, is frequently prevented from ascertaining these facts by the supposition that a dynamometer is required for his purpose. But what the indicator is to the steam engine, the ammeter and voltmeter are to the electric motor, and by the aid of these and a few simple calculations, considerable accuracy can be obtained in testing electric motors, even without the use of the dynamometer. A simple method of applying these universal instruments is described in our columns this week, by Mr. Williams, and will, we hope, be applied by power users.

INCANDESCENT LAMP EFFICIENCY.

THE recent large reduction in the price of incandescent lamps has had the natural effect of again drawing attention to an important subject involving in the highest degree the success of the central incandescent lighting station. A simple analysis had early shown that certain relations existed by which the greatest economy in the operating expenses of the station could be ascertained, these conditions involving primarily the cost of the lamp and the cost of power; and in 1888 Mr. John W. Howell, in an admirable paper read before the American Institute of Electrical Engineers showed that between very wide limits of operation the greatest economy was obtainable when the cost of lamp renewals amounted to about 15 per cent. of the total operating expenses.

It was pointed out in our last issue by Mr. H. Ward Leonard, and is now shown by Mr. Thos. G. Grier, in his paper read before the Chicago Electric Club, that the reduced price of the lamp permits it to be run at a higher efficiency, and though the renewals are more frequent the total cost of operation is reduced. It seems difficult to understand these arguments readily, but their truth must sooner or later force itself upon general recognition.

A Standard of Self Induction.

WITH the advent of dynamo electric machinery, and more particularly of alternating apparatus came the necessity for exact methods of measurement of self and mutual induction, and among the workers in this field, who have earned the gratitude of all electricians, are Professors Ayrton and Perry. Their secohm-meter was a large step in advance, placing the measurement of inductance on an accurate basis, and this, together with the standard of self induction, which we describe in another column, will go far towards removing the calculation and design of many forms of apparatus from the realm of guess-work to that of intelligent predetermination.

THE EVANS HYDRAULIC CAR GEAR.

AMONG the large number of methods and devices applied to, or suggested for, transmitting the power of the motor armature to the axles of electric street cars, is one in which a liquid is applied as the medium of transmission. This method possesses the qualities of smooth action and great regularity, while at the same time it possesses the important advantage that it permits the motor to be operated continuously at its best speed, and hence with the highest electrical economy.

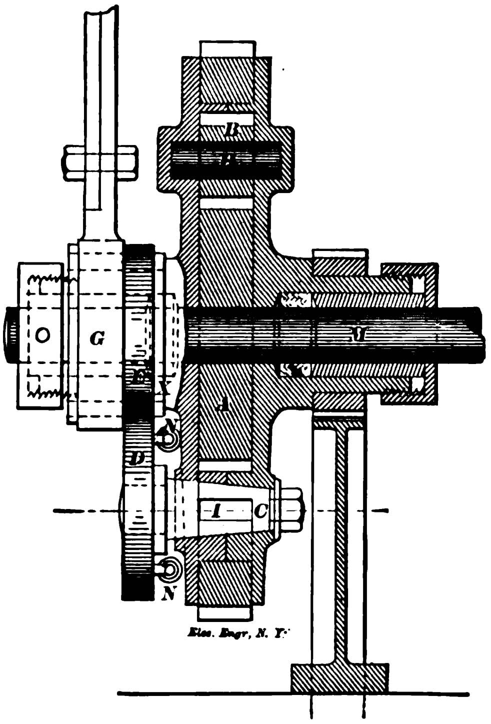


FIG. 1.—EVANS' HYDRAULIC CAR GEAR.

In applying this method to railway work, Mr. Geo. F. Evans, the inventor of the well-known Evans friction cone driving for dynamos, has designed the hydraulic gear illustrated in the accompanying engravings. As will be seen, A is a gear keyed fast on the shaft, M, which is kept in continuous revolution. The gear B being loose upon the stud, H, is free to revolve unless it is prevented by the flow of the oil through the channel, I, being cut off by closing the valve, C. This combination is arranged with a clamp, G, which grasps the loose sleeve, E, engaging the gear, D, and, when the pressure is sufficient, it closes the valve, C, automatically, for the purpose of cutting off the flow of the oil through channel I.

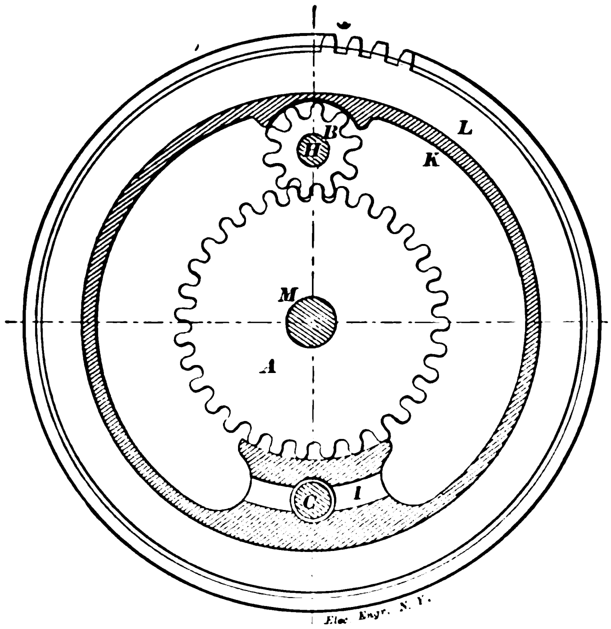
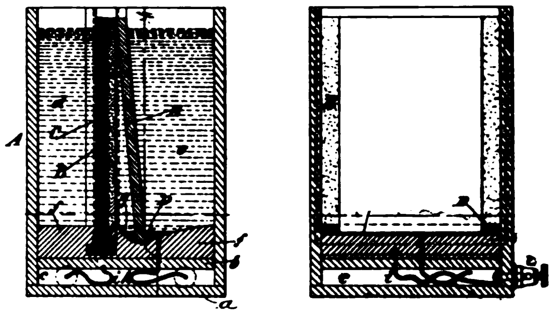


FIG. 2.—EVANS' HYDRAULIC CAR GEAR.

The gear L, which is clamped in place by the housing, K, must revolve because one chamber has been pumped full of liquid, and it will continue to run at the same speed as gear A until the pressure is released on clamp G to such an extent that the springs N N will force the valve C open, thus releasing the confined oil. Gear L will then stop, and the oil will continue to flow until the valve C is closed again for the purpose of starting gear L. With this arrangement any speed can be obtained and maintained, the combination acting equally well in either direction.

THE CROWDUS BATTERY.

WHEN connections between battery cells are made, as is customary, at the top of the cells, the charging with exciting fluid is often troublesome, and is liable to disarrange the connections. To overcome this objection, Mr. Walter A. Crowdus, of Memphis, Tenn., has invented a method by which the connections are made through the bottom of the cell to terminals on the exterior at one side or at the ends.



FIGS. 1 AND 2—THE CROWDUS PRIMARY BATTERY.

The accompanying engravings Figs. 1 and 2 illustrate the construction of the cell. The latter has a removable bottom *a* and a false bottom *b*, leaving the space *c* between them for the wire connections. Above the false bottom is a porous partition B dividing the cell into the two chambers *d* and *e*, in the former of which is the electrolyte for the negative plate, and in the latter, that for the positive.

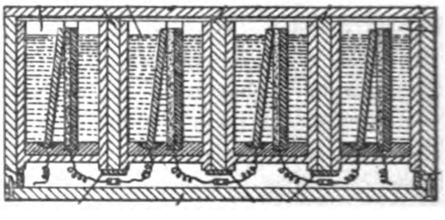


FIG. 3.—THE CROWDUS PRIMARY BATTERY.

The negative electrode C consists of a plate of porous carbon placed close to the partition, so as to assist the latter in preventing the mixing of the electrolytes, while the positive electrode, E, stands with its lower edge in a mercury bath D. The sides of both plates rest in grooves in the walls of the cell, and are held in place by a filling of wax. A wax coating is also applied to the bottom of the cell, extending under the plates as shown at *f*. The mercury trough is formed of metal and placed at the lowest point of the chamber, as shown at *g*, Fig. 1. The connecting wire *h* is soldered to the trough and drawn down through the false bottom.

The wire *i* similarly connects with the bottom of the negative plate by passing through the bottom *b*. If the plate be of carbon, its lower edge is electroplated with copper. A bar of metal is then soldered to one side of this copper rim and the wire *i* embedded in, or soldered to the bar. The wires *h* and *i* are carried through the bottom space to either side of the cell, and pass out through holes for connection with binding-posts, as shown in Fig. 2. The bottom *a* is made removable, so that the connections can be properly arranged before it is fastened on. This is the construction for single cells.

For batteries containing a number of cells connected in series as shown in Fig. 3, the cells are constructed without the bottom *a* and are arranged in a case, the wire of one cell being connected to the wire of the next at the bottom of the case.

Literature.

Hints to Power Users. By Robert Grimshaw, M. E., New York, 1891. *Cassell Publishing Co.* 6½x4¼, 160 pp. Cloth. Price, $1.

THIS is a quaint little book, written with all Mr. Grimshaw's well known force and piquancy of style. It is a series of thoughts and observations on the various questions that come up for settlement by power users, and it puts the pros and cons very clearly and effectively. The remarks, for instance, on the desirability of get-at-able boilers and on the merits of big fly wheels are pointed and pithy; and it is just such reflections as these that will help a superintendent to save many a dollar. The work discusses in this shrewd, commonsense manner about 900 different subjects, and while on some of them so little is said as to make one wish for more, it is impossible not to derive benefit and instruction from every single page. The form of the book is handy, enabling it to be slipped into the pocket; the type is large, and the index is admirable.

Aerial Navigation. By O. Chanute, C. E.: *Railroad and Engineering Journal.* N. Y. 1891. Paper, 36 pp. Price, 25 cents.

This pamphlet contains a most interesting lecture delivered by Mr. Chanute before the students at Cornell. It is a fitting resume of the work done up to the present time in the navigation of the ambient air. Mr. Chanute inclines to the opinion that great results cannot be expected of balloons, which have reached a speed of 14 miles an hour and even now could make 25 or more. Besides, balloons are unwieldy, and as they grow in size becomes unmanageable. Much greater speeds, he says, can perhaps be attained eventually with aeroplanes, imitating the action of flight, and dispensing entirely with the gas bag.

The question of the motive power is vital, and Mr. Chanute gives the results obtained with electricity by the Tissandiers, and by Renard and Krebs. Assuming that the weight of 50 lbs. per h. p. is all that could be allowed in successful aerial navigation, he shows that primary batteries and storage are alike, still too heavy. Renard's primary battery weighed 66 lbs. per h. p. per hour, to which must be added the motor, weighing, if of the Trouvé make, 26 lbs. per h. p. with accumulators. The combined weight of cells and motor ran up to 130 lbs. per h. p. Mr. Chanute gives M. Trouvé credit for a small motor of aluminum, weighing only 7.7 lbs. per h. p., and adds that he is now building one for the Portuguese Government that is of 10 h. p. capacity and weighs only 220 lbs. The 7½ lb. motor strikes us as rather visionary, and we find no reference to it in the life of Trouvé recently issued.

We recommend this little pamphlet cordially to our inventive readers. It is full of data and highly suggestive.

PERIODICALS.

IN the March and April numbers of the *New England Magazine*, George H. Stockbridge has two illustrated articles, entitled respectively "The Early" and "The Later History of Electricity in America." While it might perhaps be truthfully affirmed that Mr. Stockbridge has given rather a history of the electricians than of electricity, yet the best part of his work by far is not the history at all, but rather his appreciative, and in the main just estimate of the relative importance of the contributions of different inventors and discoverers to the magnificent results which the world is just beginning to realize. He deals mainly with the work of Franklin, Henry, Morse, Vail, Page, Farmer, Davenport, Thomson, Edison and Weston, with necessarily brief reference to many others. Although Mr. Stockbridge has not undertaken to add to the historical or biographical material in our possession, he has marshalled familiar facts in a way which at times, gives them a new and important significance. The author's sense of historical perspective is excellent, but his work is unfortunately marred by many minor inaccuracies of statement, which a little care might easily have avoided. For example, he locates Morse's original experiments at Columbia College instead of the University; he gives us the International telegraphic code in place of the one devised by Vail, known and used all over America as the "Morse code;" he tells us that Edison "employed Hughes' discoveries regarding certain qualities of carbon to the production of the Edison telephonic transmitter," the fact being that Hughes' discovery, although unquestionably of independent originality, was not known in America until nearly two months after Edison's carbon telephone had been successfully used in conversation between New York and Philadelphia. Nor can the implied assertion be admitted that the duplex telegraph of Joseph B. Stearns owes anything to Edison, or the quadruplex telegraph of Edison anything to Dr. H. C. Nicholson of Kentucky. We mention these instances because some of them are liable to perpetuate historical error in matters not wholly unimportant, and because it is by his accuracy in small things that a censorious world is prone to pass judjment upon the reliability of a historian. An article descriptive of the Thomson-Houston factory at Lynn is promised for the next number of the *New England*.

BOOKS RECEIVED.

Histoire d' un Inventeur. Exposé des Descouvertes et des Travaux de Gustave Trouvé dans le Domaine de l' Electricité. By Georges Barral. Paris: 1891. *Georges Carré.* Paper; 610 pp.; 6½x10 in. Illustrated.

Die Elektrischen Verbrauchsmesser. By Etienne de Fodor. Vienna: 1891. *A. Hartleben.* Paper; 219 pp.; 5x7 in. Illustrated. Price, $1.25.

Die Elektrischen Motoren; mit besonderer Berücksichtigung der Elektrischen Strassenbahnen. By Etienne de Fodor. Vienna: 1891. *A. Hartleben.* 214 pp.; 5x7 in. Illustrated. Price, $1.25.

Die Glühlampe. Ihre Herstellung und Anwendung in der Praxis. By J. Zacharias. Vienna: 1891. *A. Hartleben.* Paper; 195 pp.; 5x7 in. Illustrated. Price, $1.25.

Die Zeittelegraphen und die Elektrischen Uhren vom Praktischen Standpunkt. By Ladislaus Fiedler. Vienna: 1891. *A. Hartleben.* Paper; 207 pp.; 5x7 in. Illustrated. Price, $1.25.

THE LARGEST ELECTRIC MINING PLANT IN THE WORLD.

The Cœur d' Alene Silver-Lead Mining Company have contracted with the Edison General Electric company for an electric power transmission plant, to operate all the machinery and furnish light for their mill and mine at Burke, Idaho. The plant consists of two 225 horse-power Edison generators, to be located about one and one-half miles from the mill, and driven by water power from the falls of Canyon Creek, using Pelton wheels under about 690 feet head. The mill machinery will be driven by an 80 horse-power motor belted direct to the main shaft of the mill. The Ingersoll steam drill compressor now in use will be operated by a 60 horse-power motor belted to the fly wheels of the compressor. The Lidgerwood steam hoist now being used will be operated by a 50 horse-power motor geared direct to the present driving shaft. The pump, located on the 500 foot level will be driven by an 80 horse-power motor geared direct.

The entire plant is at present being operated by steam, and the application of electricity will be so arranged that all the machinery, or any portion of it, can be operated by either steam or electric power at any time. The entire electric plant will make about eight car loads, and will probably be the most extensive electric mining plant in the world. The contract was made through Mr. S. Z. Mitchell, Edison District Agent, at Portland, Ore.

ELECTRIC LIGHT IN THE SUEZ CANAL.

Thanks mainly to the electric light, the average time of transit through the Suez Canal goes on diminishing steadily from year to year. Last year it was 24 hours 6 minutes, whereas in 1889 it was 25 hours 50 minutes; in 1888, 31 hours 15 minutes; in 1887, 33 hours 58 minutes, and in 1886 not less than 36 hours. In the preceding year the average time for the transit of vessels traveling at night with electric light was 22 hours 30 minutes, and in 1890 it has reached the short and quick passage of 22 hours 9 minutes. The shortest passage through the canal by a steamer using electric light was made last year. The time was 14 hours 15 minutes, or as much as 30 minutes faster than the fastest in 1889.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER *150 Broadway, New York city.*

DISCUSSION OF THE PHENOMENA OF CURRENTS OF HIGH FREQUENCY.

It is not from any desire to have the last word that I have answered Mr. Tesla's statements as they appeared; it has simply been to correct misunderstandings. In regard to the experiment which I mention, as performed by immersing in water a lamp bulb in which a single strip of carbon had been mounted and connecting the water and the filament to a source of high potential alternating current at high frequency, and whereby the strip of carbon was brought to bright incandescence, I simply said that conduction through the glass could not have had any effect in this experiment. I made no general denial that a slight conduction occurred with even the best dielectrics. The glass in my experiment being immersed in water, the assumption of high temperature which Mr. Tesla makes as increasing the conductivity of the glass, is not to be considered in this case. The glass was only heating where it was not so immersed, and where, therefore, no connection with the circuit existed.

Mr. Tesla bases a long statement about dielectrics, insulation, resistance, perfect conductors, degrees of conductivity, etc., on the statement I made in relation to the experiment and the phenomenon it presented; and he even asks whether I have "then never measured insulation resistance" and "by a conduction current." Similar irrelevant questions follow this typical one. I have said that "if conduction through the glass were a possibility (in the experiment and accounted for the phenomenon presented) this action (of charging a lamp bulb as a Leyden jar and receiving a charge therefrom,) could not occur." Mr. Tesla does me the injustice of applying a statement which related to a particular experiment and phenomenon to classes and conditions of phenomena which any one at all familiar with the circumstances would rule out. Mr. Tesla says: "My statement that conduction is concerned to some, *though perhaps negligible,* extent in the experiment above described was, however, made not only on account of the fact that all bodies conduct more or less, but principally on account of the *heating of the glass* during the experiment." The italics are mine. In the experiment the glass was immersed in cold water, and only that portion not immersed and not in contact with the current conductor or the surrounding water, was warmed. This disposes of the paragraph of contentions of Mr. Tesla based on heated glass in the experiment.

In regard to the estimate of the number of complete waves of sound corresponding to a given number of alternations, I freely confess that I was in error, and that the number given by Mr. Tesla is correct. The number of complete sound waves does, as Mr. Tesla points out, correspond to the number of alternations, as the expansion and the contraction of the arc stream, corresponding to wave condensation and rarefaction, occurs with each alternation. This is a point which I had missed in the former consideration of the matter, but, of course, if the limit of audition is above any of the rates considered, it would not affect the argument except as it relates to the degree of approximation to that limit.

Without calling upon Mr. Tesla to state how far "Earth is from Heaven" in his view, I will simply state that my experiment of five or six years ago, which called forth his remark, certainly did teach me something then, and added somewhat to my information in certain directions.

I was perfectly well aware of the effects of self-induction, including impedance, pointed out by Mr. Tesla, when I spoke of the insertion of a coil of large self-induction into a circuit of arc lights as steadying the current and lessening its undulations. In regard to the effects of self-induction I may state that the property of impedance I have always regarded as one of those effects.

It is not true, as stated by Mr. Tesla, that self-induction "renders the undulations more pronounced." Whether it will do so or not depends on the shape of the wave of undulation. Not all shapes of wave have the greatest rate of change when the current has a small value. What is true is that [illegible] of a sine curve would not be true of a sawtooth wave. [illegible] was the effect of a large self-induction [illegible] the current was of a fluctuating character. [illegible] may be considered in this case as made up of a steady current of average current value, [illegible] which has been superimposed an alternating current value, or it may be considered as made up of a steady current of less than the average value with a pulsating current of small value superimposed. These assumptions, to be exact, of course, are made on the basis that in the fluctuations the strength of the current does not change very greatly, or that the minimum current and the maximum current values are not far removed from the average value. Now the effect of self-induction introduced into such a circuit with arc lights is, by its impedance, to diminish the value of that portion of the current which is, so to speak, alternating or fluctuating; and whether the waves of alternating or pulsating currents, so greatly diminished in amplitude, will be sharpened or smoothed out by self-induction will depend upon their original form. It is the effect of self-induction in producing impedance, and therefore restricting the value of the fluctuating or alternating current strength, superimposed on the much larger constant or steady current, to which I referred in speaking of the smoothing action. Mr. Tesla was right in his general statements of principle, but wrong in his application of them to the case in point. He was not right, however, in separating the effect of impedance from self-induction in the case under discussion.

I have no desire to prolong this discussion and will leave out of consideration any reference to effects on clutch or clockwork lamps, or to the physiological effects of currents. I have in the above comments confined myself strictly to those matters which it seemed necessary to have cleared up in some way. I hope that in stating my position in relation to the matter I have made myself clear so as to avoid further misunderstandings.

ELIHU THOMSON.

LYNN, MASS.

IMMERSING CONVERTERS IN OIL.

I have read a recent article by C. E. L. Brown on the "Uses of Oil in Insulators and Transformers." Mr. Brown states: "The application of oil as insulating material for transformers carrying a very high potential was first proposed by me," meaning Mr. Brown himself. In your journal of April 15th, Prof. Elihu Thompson writes: "It may be interesting to your readers to learn that the use of oil in converters, was the subject of a patent applied for by me on May 9th, 1887, or about four years ago, the number of the U. S. Patent being No. 428,648."

I received a patent dated Oct. 25, 1878, No. 210,987, in which the following claim was allowed: "The within-described method of insulating induction coils or bobbins of wire of electrical instruments, that is to say, by immersing said bobbins or coils in a liquid insulating substance, as set forth."

Professor Thomson's patent is titled "A casing for induction coils," and although in his specifications he speaks of the value of oil, in his claims he steers very clear of that one claim of mine. He has six claims all commencing with the words "A combination" of different things, but having little or no reference to the fundamental principle of oil being used in induction coils or converters or transformers. He doesn't make use of the words "converters" or "transformers."

DAVID BROOKS.

PHILADELPHIA, PA., April 17, 1891.

ELECTRICAL ENTERPRISE IN MANITOBA.

Mr. W. Bathgate, of the Manitoba Gas and Electric Light Company, recently invited the members of the city council to the works of the company in Winnipeg.

The boiler house is [illegible] feet long by 40 feet wide. There are nine steel boilers of [illegible] h. p. One hundred pounds of steam is carried. The smokestack is [illegible] feet high, and five feet in diameter. The engine and dynamo house is 50 feet square and contains two pairs of compound surface condensing Brown automatic engines of 300 and 400 h. p. respectively. The driving wheel of the 400 h. p. engine weighs 26½ tons, and is 18 feet in diameter and [illegible] inches face, and drives the largest belt that has been made in Canada—three ply 3 feet 4 inches wide and 85 feet long. The shafting with which it is connected is fitted up with friction clutch pulleys made by the Vulcan Iron Company, from which are run two Thomson-Houston arc machines for city lighting and one 1,000-light incandescent dynamo, with space for two more large incandescent dynamos. Three incandescent dynamos of 2,000 light capacity are run from the shafting, driven by the 200 h. p. engine as well as the arc dynamos which are used for private lighting. The total capacity of arc plant is 135 lights, 2,000 c. p.; the total capacity of incandescent plant is 3,000 lights, 16 c. p., with capacity for two more incandescent machines of 2,500 lights to be installed this fall. The pumps in connection with each engine consist of one Blake air pump, one circulating pump, one [illegible] boiler feed pump, and one large Northey auxiliary pump fitted up with [illegible] feet of 3-inch hose for fire protection purposes [illegible] steam. The workshop contains a 7 h. p. Otto gas engine furnishing power for blacksmith and machinery shops, which are fitted with two lathes, one 15 foot and one 14 foot bed, screw cutting machines, emery wheel, grindstone, drills and punching machines, all the necessary repairs for both gas and electricity being done in these shops.

Reports of Companies.

MEXICAN TELEPHONE COMPANY.

The Mexican Telephone Company, at its annual meeting in New York, on April 15, elected the following directors :—President, Robert Colgate, New York; secretary, W. H. Harrington, Boston; treasurer, W. French Smith, Boston; Orlando P. Dexter, New York; John D. Sargeant and Robert Bacon, Boston, and James H. Dawes of Kingston, Mass. The directors are the same as last year, with the exception of the last two.

ANNUAL REPORT OF THE THOMSON-HOUSTON ELECTRIC CO.

The annual report of the Thomson-Houston Co. was presented and adopted April 13. It showed an aggregate business of $10,617,661 for the year, although this total includes only the transactions of the Boston office, it being stated that the returns from the branch offices would increase the operations about 25 per cent. The growth of the business is seen as follows :

1883	$ 426,987 97
1884	700,470 46
1885	983,996 05
1886	1,405,041 74
1887	2,335,594 80
1888	4.435,902 23
1889	8,222,789 12
1890	10,617,661 67

The following is a table of the Thomson-Houston local companies :

	No. of Companies.	No. of Arc Lamps.
January 1, 1883	5	365
January 1, 1884	31	2,878
January 1, 1885	59	5,767
January 1, 1886	100	13.227
January 1, 1887	171	21,840
January 1, 1888	303	36,966
January 1, 1889	419	51,621
January 1, 1890	587	68,203
January 1, 1891	755	87,131

There are companies operating this system in England, Ireland, Sweden, South and Central America, Finland, France, Germany, Italy, Spain, Russia, Japan, West Indies, Australia; in fact, in nearly every civilized country in the world not included in the above.

Of the above, about 500 companies operate both arc and incandescent, employing between 600,000 to 700,000 incandescent lights of the Thomson-Houston manufacture.

There are also many hundreds of isolated plants in factories, hotels, etc., the number of which is rapidly increasing.

There are more than 150 lines of electric railways under contract and in operation, aggregating over 2,000 cars, as a result of less than three years' operation of this department.

It is stated that in spite of the general depression of trade, the orders received during the last 90 days are much in excess of those for the same period in any previous year. The company now has 11 large factory buildings at Lynn, and has 2,400 active customers on its books.

The balance sheet is as follows :

BALANCE SHEET, JANUARY 31, 1891.

ASSETS.

Acc'ts receivable, mdse	$6,505,117 74	
Less deductions	650,511 77	$5,854,685 97
Notes receivable	$1,752,799 25	
Less deductions	87.639 95	1,665,159 30
Cash		632,055 18
Real Estate, about 70 per cent of cost		350,000 00
Machinery and tools, about 70 per cent. of cost		400,000 00
Patterns and models		135,000 00
Patents (1.000)	$438,354 29	
Less deductions, in addition to previous deductions	100,000 00	338,354 29
Local Co.s' stock, 40 per cent. of par		346,430 00
Local Co.s' bonds, 70 per cent. of par		1,646,120 00
Manufacturing Co.s' stock, at cost		3,821,017 50
Construction Co.s' stock, at cost		1,022,500 00
United Securities Co.s' stock, at cost		487,425 00
Consignments		14,095 63
Merchandise inventory		1,476,589 15
Supply department inventory		53,554 68
Common stock, sold but not delivered		331,100 00
Premium on common stock, sold but not delivered		331,100 00
		$18,905 106 70

LIABILITIES.

Capital stock, common		$6,000,000 00
Capi'al stock, preferred		4,000,000 00
Accounts payable, merchandise		374,340 60
Notes payable, collateral		1,587,356 97
Notes payable, unsecured.		765,550 64
Mortgage		1,200 00
Accrued wages		4,124 78
Guarantee account (from accrued surplus)		200,000 00
Surplus February 1, 1890		1,685,415 92
Profits for the year,	$3,091,883 67	
Premium on common stock sold,	1,500,000 00	
Total,	$4,591,883 67	
Less dividends paid on preferred stock,	254,765 88	4,337,117 79
		$18,905,106 70

STATEMENT OF SURPLUS ACCOUNT.

Surplus February 1, 1890	$1,685,415 92	
Increase for year ending January 31, 1891,	4,337,117 79	
Surplus January 31, 1891,		$6,022,533 71

C. A. COFFIN, *Treasurer.*

The subjoined is the statement of the

PROFITS AND SURPLUS ACCOUNT.

	Added to Surplus from Profits.	Total Surplus.
January 1, 1883	$ 17,237 85	....
January 1, 1884	93,696 74	$ 110,934 59
January 1, 1885	96,187 10	207,111 69
January 1, 1886	106,687 50	313,809 19
January 1, 1887	123,006 05	426,815 23
February 1, 1888	313,596 67	750,411 91
February 1, 1889	660,828 82	1.411,240 73
February 1, 1890	1,309.175 19	1,685,515 62
February 2, 1891	4,337,117 79	6,022,533 71

The surplus account, February 1, 1889, was $1,411,240.73 *from which* there was divided among the shareholders $1,000,000 as stock dividend and a cash dividend of $35,000 on preferred stock. There was *added* from the profits of the year 1889, $1,309,175.19 making a surplus February 1, 1890, $1,685,415.92.

In explanation of the small increase in the surplus of 1890 over that of 1889, it should be stated that there were delivered to trustees of Thomson-Houston trust securities "Series D" as a dividend to holders of the common stock, securities and claims amounting at face value to $2,410,289.13.

It is further remarked with regard to the division of profits : "It may be proper, in view of the policy recently adopted of paying cash dividends to the holders of the common stock, to refer to the dividends which have heretofore been received by the stockholders of the company in other than cash payments."

"The profits received from the different 'series' of trust securities, together with dividend of 40,000 shares of common stock computed at $25 per share, have been equivalent to an average annual dividend to the holders of the common stock of a little more than $14 per share during the eight years of the present management of the company. This has no reference to, and does not include the large amounts paid from time to time for rights to subscribe to new issues of the common stock of the company. In addition to these dividends there is an accrued surplus derived from the profits of the company, exclusive of premium received from the sale of common stock of $4,522,533.71."

DIVIDENDS.

SOUTH PITTSBURGH, TENN.—The South Pittsburgh Electric Light & Power Co. has declared a dividend of 5 per cent.

ELECTIONS.

SOMERVILLE, MASS.—At a meeting of the directors of the Somerville Electric Light Co., held March 30, F. Ellwood Smith was elected treasurer and business manager, vice, F. S. Pearson, resigned. After May 1st, the Boston office will be discontinued and all business will be transacted in Somerville.

FALL RIVER, MASS.—The organizers and incorporators of the Fall River Electric Freight Road held a meeting recently and elected the following board of directors : F. L. Ames, Thos. S. Stevens, Jr., Wm. S. Greene, Spencer Borden, Philip L. Saltonstall and Joseph F. Jackson. The following day the directors met and elected Philip L. Saltonstall treasurer, and Joseph F. Jackson clerk of the company.

LANCASTER, N. H.—At the annual meeting of the Lancaster Electric Company, the following officers were elected ; President, H. W. Burgett; secretary and treasurer, W. E. Bullard ; directors, H. W. Burgett, Frank Smith, Lewis H. Rogers.

THE JAMAICA AND BROOKLYN ROAD CO., announces the issue of first mortgage gold bonds to the amount of $500,000, at 99 and accrued interest, payable Jan. 1st, 1930. Subscriptions will be received by the Brooklyn Trust Co.

Society and Club Notes.

NEW YORK ELECTRIC CLUB.

The following ticket was elected at the annual meeting of the club on April 16:—*President*, Samuel Insull; *Vice-Presidents*, Charles W. Price, Erastus Wiman, W. L. Candee, Edward Weston; *Secretary*, S. L. Coles; *Treasurer*, Geo. M. Phelps; *Board of Managers*, H. L. Shippey, P. H. Alexander, T. C. Martin, C. E. Stump, E. F. Peck, E. E. Bartlett, Dr. J. B. DeLery, H. D. Cheever, Chas. D. Shain, Joseph Barré, C. O. Baker, Jr., H. D. Stanley, J. H. Herrick; *Committee on Membership*. Charles Dutton, C. H. Barney, Geo. T. Manson, S. S. Wheeler, Joseph Wetzler.

An exhaustive report and balance sheet prepared for the members by Gen. O. E. Madden, and verified by an expert accountant, showed the club to have a surplus of $3,677, and a membership of 308, not including 19 recently elected.

After the declaration of the result, a vote of thanks was tendered to the tellers. Messrs. Bishop and Colby and to the retiring board of officers. It is proposed to celebrate the fifth anniversary of the club with a dinner on May 5.

THOMSON SCIENTIFIC CLUB.

At the last regular meeting of the Club, the members were entertained by Mr. Howard S. Rodgers, who gave a very interesting talk about the Electric Street Railway systems in Cincinnati, O., telling many amusing anecdotes about the struggles of the pioneers in the business in that city.

Much interesting discussion following regarding the comparative efficiency of single and double trolley systems. The experiment of inviting the ladies to the lectures has proved to be a very pleasant success and of great pleasure to all.

CHICAGO ELECTRIC CLUB.

On Thursday evening, April 16th, the annual election of officers was held. As there were several tickets in the field, the interest evoked was very great, and after a hotly contested election the following ticket was elected:—

President, B. E. Sunny; *Vice-Presidents*, F. B. Badt, Alex. Kempt, D. P. Perry, Geo. C. Bailey; *Secretary*, W. A. Kreidler; *Treasurer*, F. S. Terry; *Managers*, F. E. Degenhardt, chairman, E. Baggot, J. P. Barrett, F. G. Beach, W. H. McKinlock, E. R. Gilman, M. A. Knapp, F. W. Parker, W. B. Pearson, C. H. Wilmerding; *Membership Committee*, C. C. Haskins, Geo. Cutter, G. A. E. Kohler.

Legal Notes.

A QUESTION OF OWNERSHIP.

The Essex Electric Railroad Company directors have been subpoenaed to appear in the United States Circuit Court, May 5, to answer in a bill in equity brought by the Johnson Steel Rail Company to restrain the Essex Company from using the Essex interlocking chair, an invention of Mr. David N. Cook, of Salem. The Johnson Company claim that the Cook chair is an infringement upon its patent and demand damages from the Essex Company. The respondents deny that the Essex or Cook chair is an infringement, the application of its principle to the rail being entirely different from that of the Johnson. The Essex Electric Company is using the Essex chair.

THE NEW ENGLAND PRINTING AND TELEGRAPH CO.

The New England Printing and Telegraph Co. have followed up their petition for a mandamus against the Boston board of aldermen, by a petition of the same sort against H. H. Carter, superintendent of streets. The court is asked to grant a mandamus against Carter to compel him to issue permits to the company to allow them to dig up the streets in which the board of aldermen of 1890 gave the company a right to erect poles.

LYNN, MASS.—The marriage is announced of Mr. A. L. Rohrer, chief electrician of the Thomson-Houston Electric Co at Lynn, to Miss Carrie L. Gould, of that city.

Appointments, Etc.

MR. FRANK PIERCE of St. Paul has been appointed electrician of the Electric Light and Street Railway works at Great Falls, Montana.

MR. GEORGE M. BROWN, for the past five years manager of the Southern New England Telephone Co. in Rockville, Conn., and local operator for the Postal Telegraph Company, has closed his engagement, to accept an excellent position in the central office at Hartford.

MR. E. A. SWEET has concluded his services as electrician for the Electric Light & Power Co., of Milford, Mass. He has been in the employ of the local company about two years.

MR. R. W. GRAY has been appointed to fill the office of city electrician at Waco, Tex., recently created by the city council.

MR. R. W. ROLLINS, district engineer of the Westinghouse Electric Co.'s New England department, will sever his connection with that company on May 1st, to take the position of assistant superintendent of the Hartford (Conn.) Electric Light Co.

MR. GEORGE E. BLISS, electrician at the Malden, Mass., electric light station, has accepted the position of permanent manager of the electric works at Harrison, N. J., and has removed there with his family.

MR. G. W. KÜCHLER has been placed in charge of the electrical department of the Roessler & Hasslacher Chemical Co., of this city, who have been introducing the new insulating material "Isolatine."

MR. THOMAS H. HEALEY, who of late has held a responsible position in the Southern New England telephone office in New Haven, has been promoted to the position of assistant operator of the Hartford Telephone Exchange.

CAPT. J. C. WILSON, who has been the efficient superintendent of the Northwest Electric Company for the past year, goes from Winnipeg to Toronto to re-enter the service of the Edison Company.

MR. HENRY C. EDDY has resigned as Western manager of *The Electrical World*, which position he had gracefully retained for a period of nearly six months.

MR. A. H. CHADBOURNE, lately of Chadbourne Hazelton & Co, has joined the forces of the Westinghouse Electric & Manufacturing Co., and will represent the Company's railway department at their Philadelphia office in the Provident Life Building.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of April 18, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	81½	Edison Gen. Elec. Co.	96½
American Tele. & Cable	82	Edison Gen. Co. Def'd	....
Centl. & So. Amer.	*145	Consol'd Elec. Lt. Co.	...
Mexican	*210	Edison Illn'g Co. N. Y.	78
Com. Cable Co.	105	U. S. Elec. Lt. Co.	20
Postal Tel. Cable	39	North Am. Phonograph	...

BOSTON.

	BID.		BID.
Thomson-Houston	47	Ft. Wayne Co.	12½
" Pref'd	25½	Am. Bell	205
" Series C.	9	Erie	48¾
" " D.	7½	New England	50¼
" Int. Co.	....	Mexican	.85 cts.
Thomson Welding Co.	....	Trop. American	.85 cts.
Thomson Eu. Welding	55	Edison Phon'gph Doll	.50 cts.

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash.)	174½
Ches. & Pot. Telephone	58	Eck. & Sold. Home Elec. Ry.	55
Amer. Graphophone	5¼	Georgetown & Tenallytown	62

*Ex. Dividend.

PITTSBURGH.

Westinghouse El. Man. Co. .... | 14

THE INCANDESCENT LAMP.[1]

BY THOS. G. GRIER.

INCANDESCENT lighting is now merging into a second decade of commercial life, and any neglect on the part of the electrical fraternity to fully understand the importance which the incandescent lamp plays in this growing industry is suicidal to their interests.

The limited knowledge and the absence of any reliable data on incandescent lamps led the Franklin Institute, in 1884, to invite the manufacturers of incandescent lamps to place samples of their lamps in the hands of an impartial committee of experts for a comparitive test. These results were published in September, 1885, and from the official report a few results have been compiled.

Five different manufacturers submitted their lamps, some submitting several batches of different voltages. The lamps were tested for duration or life, aud before placing on test their initial efficiency per spherical candle-power was determined.

The results of the tests showed that the greatest depreciation in candle-power was 50 per cent. and the least 33 per cent. This, however. can not be taken for any comparison as the life of the lamps showed such a great disparity. The depreciation of the Edison lamps, which proved the superior in the test was 35 per cent. These results are looked upon to-day as of little practical value except as historical record, but they have taught us that lamps are a delicate matter to handle, and whether a lamp is a lamp of value depends on many circumstances.

Since 1884 many other makes of lamps have come on the market, and knowledge gained by experience has both improved the quality of the lamps and cheapened the process of manufacturing. In 1884, lamps were advertised for 16 c. p., $3.00; to-day from 40 cents to 60 cents may be taken as an average price.

Six years now have passed since the Franklin Institute experiments, and we are almost as much in the dark as in the earlier days of the industry. The question of life seems to be the most important factor to be considered from the central station point of view, and to meet this desire various manufacturers frequently guarantee the average life of their lamps. Those guaranteeing the longest life and at the same time proving their guarantee usually get the majority of the business.

There is not the least trouble in making an incandescent lamp for any desired life, as the life of a lamp depends upon the efficiency at which it is burned. John W. Howell, in 1888, published a statement based upon the experiment of the Edison Company, which covered five years of time, and the use of thousands of lamps. In this statement he says the life of a lamp burned at two watts efficiency was practically zero; at three watts per candle it was 1,000 hours; at four and three-fourths watts per candle power it was 16,000 hours. This at once shows that the question of life is merely a question of circumstances and may, or may not be, advantageous.

The object of an incandescent lighting station is to produce light. It is necessary to develop electrical energy, but it is the lamp that transforms this electrical energy into light. The electrical energy represents the dollars of the investor and operators of the station, and it is most important that it should be used with the greatest economy to obtain proper reward for the investor. This, of necessity, brings into the question the lamp used; the life, the cost, and the efficiency being the three considerations.

To bring the matter to a point at once we will assume conditions which are perfectly feasible and within the bounds of possibility. First, we will consider that a lamp burning at 4½ watts efficiency will depreciate but a minimum for the first 1,000 hours. We will consider this lamp and the cost of operating it. A lamp at 4½ watts efficiency and 16 c. p., burning for 1,000 hours, would require a total expenditure of electrical energy of 72,000 watt hours. This, at one cent for 50 watt hours would be $14.40, for the current, and, adding 50 cents for the cost of the lamp, would make a total cost of $14.90, for burning this lamp 1,000 hours. The efficiency of another lamp is 3½ watts per c. p. We will not say how many lamps will have to be replaced in the 1,000 hours, but just assume that the efficiency of 3½ watts per c. p. is maintained throughout the 1,000 hours. The total expenditure of energy on this basis will be 56,000 watt hours, which will cost at the rate of one cent for 50 watt hours, $11.20. Adding 50 cents to this for the cost of the first lamp, makes it $11.70, eaving a difference in favor of the 3½ watt lamp of $3.20, which, of course, will have to be used to a certain extent in replacing the amps; but allowing that a 3½ watt lamp will maintain its efficiency for 333 hours, we will merely have to pay $1.00 additional or replacing lamps and have a net saving of $2.20. This, though n assumption, is not distorted, for lamps from 3½ to 4½ watts efficiency are on the market. And yet, many a station is being perated with lamps of a lower efficiency than 4½ watts, and they wonder why it is that their dividends are smaller than those of ther plants. It is the incandescent lamp that will make or break he dividend-paying record of the central station and it should be onsidered with the utmost care. The assumption has been made and the question been analyzed. The lack of actual data makes it necessary to assume and analyze the question as it has just been done. However, the London *Electrical Review* has published some facts which will be analyzed, as this assumption has been, and will show immediately the advisability of maintaining efficient lamps on a circuit, even though their life be short.

The London *Electrical Review* published an account of a test on Edison-Swan lamps and the results were presented in tabulated form, giving the initial candle power, the initial efficiency and the total watts used on the lamp. A test of 1,000 hours duration was started, and at the end of each 100 hours observations were made as to the candle power and the total energy, the efficiency of the lamps being computed and placed in the table. The first four columns of the data are furnished by the *Electrical Review*, the other columns are deductions drawn from the first four columns.

Hrs.	c. p.	Watts per c. p.	Total watts.	Average of each 100 hours.		Cost figured on the basis of 1 cent for 50 watt hours.	
1	2	3	4	5	6	7	8
				Average c. p.	Average total watts.	Cost for each 100 hours.	Cost of 16 c. p. at each 100 hours.
0	19.3	3.34	64.46				
100	18.8	3.45	64.86	19.05	64.66	$1.293	$1.08
200	17.2	3.79	65.19	18.00	65.03	1.300	1.16
300	15.6	4.10	63.96	16.40	64.57	1.297	1.26
400	15.2	4.17	63.38	15 40	63.67	1.270	1.32
500	14.8	4.29	63.49	15.00	63.44	1.268	1.35
600	14.4	4.38	63 07	14.60	63 28	1.264	1.38
700	14.1	4.50	63.45	14.25	63.26	1.265	1.42
800	13.3	4.68	62.24	13.70	62.85	1.257	1.47
900	12 4	4.90	60.76	12.85	61.50	1.230	1.53
1,000	12.0	5.00	61.00	12 20	60.88	1.207	1.58

Column 7 shows what the customer pays each 100 hours for the lamp he is using. Column 8 shows what he pays for each 16 c. p. of light he gets for each of the 100 hours. These figures are computed upon the average of the observations; that is, for the first 100 hours the average candle power produced is taken, and so on, for each succeeding 100 hours. The cost of the electrical energy used in the estimate is one cent per 50 watt hours, the prevailing price at the present day.

The potential in these experiments was constant, the same as any ordinary central station endeavors to maintain. The resistance of the filament increases as the lamp continues to burn and the total energy used, when the potential is constant, decreases, and the lamp takes less current to a small extent than when it starts to burn. The relation of the candle power to the total energy shows, that, though less energy is used as the life continues, the economy of the lamp is greatly lessened because the light produced decreases (due to the depreciation of the filament and the discoloration of the glass), in a much greater proportion than the total energy

The financial results in the above table are very clear and plain, and any one would say at a glance, allowing that a 16 candle power lamp costs 50 cents, that it would not cost the consumer a cent more for light if he bought a new lamp at the end of 900 hours, for the saving in current would pay for the lamp; that much is apparent.

Tables were submitted showing that for this grade of lamp at the price of current and price of lamp assumed, though the lamp will last 1,000 hours, it is better to throw the lamp away at the end of 400 hours and use new ones. Seventy-five cents per lamp will be saved every 1,000 hours by replacing the lamps every 400 hours instead of keeping one lamp in 1,000 hours.

If the lamps were cheaper and the currents the same or dearer, it would be cheaper to replace the lamps still oftener than 400 hours. If the current was but half of what is assumed, that is, if the current cost but one cent for 100 watt hours, it would be cheaper to replace the lamps every 700 hours, cheaper by about 17 cents, for every 1,000 hours.

It is not a question of the life of a lamp alone that should determine what lamps should be used, but also the efficiency of the lamp, cost of current and price of lamp. A mathematical equation should be formed taking all these factors into consideration before the matter should be decided by the central station. Reliable data on the majority of the makes of lamps is not obtainable, and it has been necessary to treat the matter from assumption and from analyzing such data as have been published; but even from mere assumption it is without doubt an assured fact, except when the current is extremely cheap that an efficient, short lived lamp is preferable to an inefficient long lived lamp.

In making this mathematical equation, the end in view is to determine the efficiency at which the sum of the costs of power and lamps is a minimum, and in order to do this the rate of variation of life of a lamp with its efficiency should be known. This variation would have to be given by the manufacturer. To give this equation in the shape of a formula we will assume symbols to represent the various factors.

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[1] Abstract of a paper read before the Chicago Electric Club.

Let A = the number of watt hours required by a 16 c. p. lamp
$A \div 16$ would represent the efficiency per c. p.
" B = the life of the lamp at $A \div 16$ efficiency.
" Y = the cost of a 16 c. p. lamp.
" X = the cost of a watt hour delivered at the lamp.

The value of A and B must be ascertained from the manufacturer.

To obtain the cost of a watt hour, or X, delivered at the lamp, the mean current at the station must be determined. The wires and devices have been figured for a certain loss for maximum current. The energy in transmitting the mean current would bear the same ratio to the percentage, figured for the maximum load, as the mean current does to the maximum current. This amount of energy must be subtracted from the total energy developed and the remainder will give the amount of energy used in the lamps. The total operating expenses, less the cost of the lamps, divided by the total watt hours delivered at the lamps will give the cost of one watt hour.

The cost of operating a 16 c. p. lamp for an hour would be the cost of a watt hour multiplied by the number of watts required by the 16 c. p. lamp, or $X \times A$.

The proportion of cost for replacing lamps would be the price of the lamps divided by the life or $Y \div B$.

The most economical point to run the station would be when the sum of the renewals and the cost of the energy is a minimum or expressed in a formula when $(Y \div B) + (X \times A) =$ a minimum.

To give an example of this we will assume the following conditions. Let cost of lamp = \$0.50 cents; efficiency, $A \div 16 = 4$ watts, or $A = 64$ watts, let X = \$.00016, an average cost of electrical energy, (being .8 of a cent for 50 watt hours); and the life of lamp 1,000 hours and substituting these values in the formula we have, $.501{,}000 + .00016 \times 64 = .0005 + .01024 =$ \$.01074.

Another lamp costs 60 cents, its efficiency is 3 watts or $A = 48$ watts. X = the same as in previous case, \$.00016, and the life of lamp 300 hours, substituting these values in the formula, we have $.60 \div 300 +$ \$$.00016 \times 48 = .002 +$ \$.00768 = \$.00968.

The result shows that a lamp costing 60 cents, and having a life of only 300 hours with 3 watts efficiency, makes the operating expenses of the station less than if the lamp was only 50 cents and had a life of 1,000 hours with 4 watts efficiency, in fact, the 3-watt lamp is cheaper even though the 4-watt lamp cost but one cent and had a life of 10,000 hours, for the cost of the energy alone for the 4-watt lamp is in excess of the sum of the cost of lamp and energy in the case of the 3-watt lamp. The question is governed very much by the cost of the energy.

The success or failure of electric light central stations as a dividend earning investment, is of the utmost moment to the agents, manufacturers of electric light apparatus and others who desire to promote the business. It is necessary for the success of those desiring to promote the electric light business that the electric light central stations make money. For the electric light central stations to be financially successful, those operating them should be convinced of the importance of using efficient lamps and of renewing them as soon as their efficiency materially depreciates.

ELECTRICITY AS APPLIED TO RAILROADING.

In a recent address delivered before the Young Men's Christian Association of the Delaware, Lackawanna and Western R. R., Mr. P. H. Brangs, electrician of the railroad, gave a very complete account of the various ways in which electricity is applied to the operation of railways. He traced the history and nature of the railway telegraph, and showed how it led to the development of railroad signals in which the electric current plays a prominent part. Under this head Mr. Brangs gave the following interesting details:

When the railroads of this country had grown to such proportions that the trains had to be run under short headway, it was found essential to adopt some plan whereby the safety of travelers might be made to depend upon something better than the caution of the engineer, and out of that necessity was developed the block signal.

The first railroad signal that was operated in this country was tested on the old Camden and Amboy railroad, now a part of the Pennsylvania railroad system. It was in the summer of 1863 that the midnight train from Philadelphia was filled with wounded soldiers returning home to Eastern hospitals. The train was delayed by a hot journal at Bristol. One hour later the Washington express from Richmond Junction following it, not knowing of the delay of the preceding train, crashed into it, causing one of the most frightful railroad accidents on record. Mr. Robert Stewart was at that time employed on that road as telegraph superintendent, and was the first man to construct and experiment with railroad signals in this country. Very crude signals were used at first, which were changed from time to time until the present form of semaphores was adopted. In 1870 to 1878 the "block signal" system came into general use throughout the country. The Pennsylvania Railroad Company equipped their entire line from New York to Philadelphia, and during the Centennial year a thorough test of its practicability was made. Not a single accident can now be recalled due to the improper or inefficient operation of this system. The different systems now in use in this country are the Sykes or English block, the Union Switch and Signal Company's electro pneumatic system, the Union Switch and Signal Company's, clockwork system, the Black automatic mechanical block system, the Hall automatic electric system, and numerous others.

In the Switch and Signal Co.'s pneumatic electric block system, in operation for eight miles on the New Jersey Central Railroad, the New York Central, West Shore and others, the blocks vary in length from 1,000 to 1,800 feet, and are operated on four parallel tracks. At the commencement of each block, signal posts are erected, one for each track. Each post carries two semaphores; the upper or home semaphore has a square end and is painted red, the lower or distance signal, being fishtailed in shape and painted green. At night powerful lamps are used. When the upper semaphore projects at right angles from the post, it indicates that a train is on the next block. Whenever it projects at an angle of 30 degrees, the lower one is also set at danger or caution. As the train leaves the block thus protected the upper signal falls, but the fishtail signal remains at caution until the next block is reached and the train is two blocks distant. Each semaphore is connected with a counterweight, so that when left to itself the counterpoise drops by gravity and sets it at danger. Directly below each post is a pneumatic cylinder with a single acting piston, which is connected by means of a balance lever and connecting rod to the semaphore arms. As arranged, the piston which works with the cylinder is pressed upwards to its highest position when the semaphore is set at danger, this, therefore, being the natural position of the whole apparatus.

At the top of the cylinder a valve is arranged which can be opened electrically, and which closes automatically by a spring. To this valve a pipe is connected which communicates with a supply of compressed air. Above the valve is an electro-magnet, the armature of which is connected to the valve stem. If a current of electricity is sent through the magnet, the valve will be opened, compressed air will be admitted above the piston, which will be depressed, and as it goes down will force the semaphore, in opposition to the counterpoise weight, into the "safety" position. The object to be obtained, therefore, is that when a train is on the block in advance of a set of signals, it must, automatically, cut off the current from both, so that they will be drawn into the "danger" position. When the train is on the next block the current must again be permitted to pass through the upper semaphore magnet, forcing it into the "safety" position, but no current must be admitted to the lower semaphore magnet until the second block has been passed.

Another block system, which has been quite extensively introduced on the roads of this country is known as the "Hall system." It was first used on the Eastern Railroad (now Boston and Maine) in 1871. In this system the signal is now operated on a closed circuit, running from the battery through the block track instrument, through the magnet of the signal instrument, through the points of the relay, through the relay magnets and back to the battery, thus completing a circuit which holds the signal to safety simply by the action of the current. By the momentary breaking of the circuit caused by the passage of a train over the closed spring track instrument, the magnets of the relay are demagnetized, the points are separated and the signal falls to "danger" by gravity from lack of force to sustain it in the "safety" position. It will also be seen that any disturbing cause, such as the breaking or crossing of the line wire, the failure of the battery or any of the mechanical parts, the signal will immediately go to danger by the interruption of the circuit. After a signal has been set at danger it can not be restored until the train shall have operated the clear (open) track instrument at the end of the section. The clearing circuit runs from the battery through the open spring instrument, then through the relay magnets, back to the battery. On completing the circuit through the "clear track" instrument, the relay magnets are magnetized, the points of the relay are again brought in contact, the former circuit is therefore completed and the signal again goes to "clear." If a switch on the main line is misplaced, a circuit is broken in a switch machine attached to the switch, which also causes the signal to fall to "danger." The signal instrument is certainly most simple in construction, consisting of a pair of electro-magnets, between the prolonged coils of which revolves an armature. To one wing of this armature is attached the disc, and to the other its counterweight rod, which being lighter than the signal, allows of a gravity movement of the signal whenever the force holding it is withdrawn. In the "Hall Track Instrument" the piston, on being thrown up by depressing the lever, breaks or makes a circuit on the top plate. The piston is operated in an air chamber, which cushions the upward blow and also retards its fall, thus saving all wear to the apparatus.

Mr. Brangs also described the modern system of electric railways and the various applications of lighting, heating, etc., of railroad cars.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 14, 1891.

Alarms and Signals :—

Light Signal System, B. J. Noyes and H. F. Eaton, 450,182. Filed April 5, 1889.

A system of light-signals specially adapted for police service.

Non-Interference Signal Box, W. H. Kirnan, 450,239. Filed Aug. 18, 1890.

Relates to the mechanical and electro-magnetic disabling or retaining devices.

Fire Alarm and Telephone System, S. W. Ludlow, 450,245. Filed July 12, 1890.

Combines a fire alarm and telephone system, in which an alarm of fire may be communicated automatically to a telephone exchange over the ordinary telephone circuits.

Thermostat, W. F. Singer. 450,260. Filed July 29, 1890.

Contact-points carried by spring arms ; two independent bottoms of the thermostat box are each held normally in position by fusible plugs.

Electric Time Call, R. Varley, Jr., 450,390. Filed Nov. 18, 1890.

Adapted especially to use in hotels, for calling guests at specified hours.

Heat Annunciator, A. Reinemann, 450,425. Filed May 31, 1890.

A thermostat. A yielding vessel contains two or more chemicals or substances separated by an easily fusible partition. When the partition melts the chemicals combine and evolve gases that expand the yielding vessel, which operation actuates electrical contacts.

Electric Signal, R. H. Gruschow, 450,458. Filed Nov. 21, 1890.

An electric signal system for steamboats for establishing communication between the officer in command and the engineer.

Fire Alarm and Telephone System, S. W. Ludlow, 450,466. Filed Oct. 25, 1890.

Same in purpose as No. 450,245 above.

Electric Call Bell and Indicator, W. Cox, 450,558. Filed April 11, 1890.

Mechanical details for an electric house-call system.

Conductors, Conduits and Insulators :—

Mechanism for Carrying Wires through Conduits, F. A. Wessel, 450,206. Filed Sept. 24, 1890.

A contrivance for sending a wire or cable through a conduit, and operated from the end of the conduit where the wire or cable is inserted. Consists of two self-clamping carriages one of which carries the wire or cable, and which, operated by a rope at the end of a conduit, can be made alternately to clamp themselves against the wall of the conduit and draw one another forward.

Insulator, C. A. Lieb & E. Lavens, 450,294. Filed Dec. 8, 1890.

A "bell" insulator especially adapted for railway conductors.

Electric Wire Insulator, D. A. Bertolette. 450,384. Filed Dec. 12, 1890.

A cylindrical insulator with peculiarly designed water-sheds.

Electric Wire Connection, E. J. Gatley, 450,581. Filed Feb. 7, 1891.

Intended especially for electric arc-light circuits, and adapted for use in connecting lamps to their conducting wires.

Holder for Electric Cables, J. W. Marsh, 450,589. Filed Sept. 12, 1890.

For securing electric cables upon the reels on which they are wound for shipment or storage ; especially intended to protect the cables from moisture and injury.

Distribution :—

System of Electrical Distribution, C. J. Van Depoele, 450,511. Filed Sept. 19, 1890.

Is in part an amplification of the invention patented to the same inventor Sept. 9, 1890, No. 436,275. Consists, chiefly, in employing electro-chemical counter-electromotive force devices as a means for regulating the current supplied to reciprocating electro engines.

Dynamos and Motors :—

Dynamo Electric Machine, W. F. Collins, 450,219. Filed Feb. 18, 1890.

Relates to the construction of the field-magnets.

Insulation of Armatures for Dynamo Electric Machines. R. Eickemeyer, 450,367. Filed Aug. 28, 1890.

The armature drum or core is clothed on its face with an inner layer of narrow insulating material laid diagonally from end to end, and an outer layer of the same laid diagonally but reversely to the inner layer ; the whole being then well charged with liquified or adhesive insulation.

Automatic Switch for Electric Motors, F. E. Whipple, 450,441. Filed Oct. 13, 1890.

A rheostatic switch of the class adapted to apply current to a motor in gradually increasing amount.

Electro-Magnetic Reciprocating Engine, C. J. Van Depoele, 450,543. Filed Dec. 29, 1890.

Comprises a magnetic shield or envelope, motor coils within the envelope, a magnetic system adapted to be reciprocated within the motor coils, and magnetic extensions from the envelope toward the interior of the coils.

Pulsating Current Electric Motor, C. J. Van Depoele, 450,544. Filed May, 26, 1890.

Combines, with a source of continuous and pulsating currents, a motor having a closed circuit armature encompassed by an inducing coil in circuit with the source of pulsating current, and field-magnets of constant polarity reacting upon the poles induced in the armature.

Armature, Lam. C. Atwood, 450,552. Filed Oct. 28, 1890.

Design and details of construction for a ring armature.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, W. A. Crowdus, 450,285. Filed Oct. 8, 1890.

Battery cell has a metallic trough in its bottom and a conductor leading from the trough to the exterior ; a bath of mercury is placed in the metal trough and the lower end of an electrode is immersed in the bath of mercury, whereby the mercury forms connection between the electrode and the metallic trough.

Porous Cells for Galvanic Batteries, W. Burnley, 450,354. Filed Oct. 21, 1890.

Consists of a shell of pasteboard or wood veneer.

Lamps and Appurtenances :—

Art of Making Filaments for Electric Lighting, S. F. Van Choate, 450,304. Filed May 31, 1890.

Consists of a filament or base built up and composed of aluminum and iodine ; the filament is built up by electroplating from a liquid solution composed of alcohol, iodine and aluminum ; the liquid solution is composed substantially in the proportion of one pound of alcohol, three grains of crystalized iodine and two grains of aluminum.

Measurement :—

Instrument for Measuring Electric Currents, H. H. Cunynghame, F. L. Rawson and O. E. Woodhouse, 450,121. Filed April 1, 1887.

An electro-magnet has oppositly arranged poles, an armature is mounted on a vertical axis between said poles, the horizontal axis of which corresponds to that of the electro-magnet, a torsional spring is connected to the armature.

Medical and Surgical :—

Regulator for Electro Therapeutic Apparatus, J. H, Davis, 450,577. Filed May 12, 1890.

A rheostatic regulator for medical batteries.

Miscellaneous :—

Multiple-Fuse Cut-out, A. W. Jones, 450,159. Filed Dec. 6, 1890.

Relates to a multiple fuse cut-out in which a series of fusible strips are so arranged and combined in relation to movable and fixed contacts that the fusible strips may be successively brought into circuit as required.

Circuit Closer, W. C. Johnston, Jr., 450,292. Filed December 17, 1888.

A circuit closer in which the contact surfaces slide over each other especially designed to prevent the accumulation of foreign matter between the contacts and to keep them polished.

Rheotome, G. E. Pragnell, 450 319, Filed April 12, 1890.

An automatic circuit breaker especially adapted to electric bells.

Electric Switch, F. Adam & J. Knapik, 450,551. Filed Nov. 18, 1890.

A "snap" switch for incandescent light circuits.

Railways and Appliances :—

Trolley for Electric Railways, A. S. Hickley, 450,153. Filed Apr. 14, 1890.

So constructed that upon encountering an obstruction the trolley and its immediate support will be separated from the supporting arm without breaking ; the invention also includes lubricating devices for the trolley wheel.

Non-Sparking Clamp for Trolley Wires, C. A. Lieb, 450,163. Filed Nov. 28, 1890.

Combines with a holder for trolley wires a flexible current conveying device adjacent to the holder and in electrical connection with the wire. The flexible or yielding metallic current conveyer engages with the trolley wheel during the entire time that it is adjacent to the hanger, thus preventing sparking in case of "jumping" between the trolley wheel and the trolley wire.

Electric Railway Wire Support, C. A. Lieb, 450,164. Filed Dec. 10, 1890.

A strain equalizer to neutralize the effects of expansion and contraction.

Electric Switch for Electric Railways, F. Mansfield, 450,172. Filed Nov. 18, 1890.

For connecting and disconnecting branch conductors of an electric railway with the main conductor ; adapted for use with the electric railway system patented to the same inventor July 22, 1890, Nos. 432,673, 432,674, and 432,675.

Electric Switch for Electric Railways, F. Mansfield, 450,173. Filed Nov. 18, 1890.

For making and breaking the circuit of electric railways and adapted to the system shown in the patents enumerated in the entry next above.

Trolley Device, A. Palmros, 450,184. Filed Jan. 8, 1891.

Trolley designed and constructed to adjust itself automatically to the circuit wire upon curves, switches, etc.

Rail-Connection with Supplemental Wire, C. A. Robinson, 450,198. Filed Sept. 22, 1890.

Claim 1 follows :

The combination, in an electric railway system, of the rails, a parallel copper rod connecting the sections of the same, a supplemental return circuit wire running longitudinally between the rails, and a copper strap connecting said rod and supplemental wire.

Trolley-Wire Support, C. A. Lieb, 450,242. Filed Nov. 14, 1890.

Comprises a cross-bolt, a threaded metallic piece through which the cross bolt passes, and insulating material between them.

Trolley Guide, W. E. Jackson, Jr., 450,489. Filed Nov. 14, 1890.

Has a guide or finder pivoted to the trolley pole below the wheel, and actuated by an electro-magnet on the upper end of the pole, the guide or finder being normally held depressed, but adapted to be thrown upward upon occasion.

Reciprocating Electric Railway Motor System, C. J. Van Depoele, 450,542 Filed Sept. 19, 1890.

Claim 1 follows :

A reciprocating electric railway motor system, the combination, with the vehicle to be driven, of a source of defined rising and falling current moving therewith, a reciprocating motor concentric with the axle thereof and having a plurality of motor coils, each provided with a movable magnetic piston directly connected thereto, and means for supplying the defined currents to the motor coils in succession.

Electric Railway, R. M. Hunter, 450,586. Filed June 4, 1889.

Claim 2 follows :

In a branching electric railway, a main line conductor and a branch line conductor extending along the main line and branch tracks, respectively, and electrically connected, in combination with two distinctly located generators, one connected to the main line conductor and the other connected to the branch line conductor.

Electric Wire Supporter, C. A. Lieb and E. Lavens, 450,587. Filed Dec. 8, 1890.

A supporter of the "bell insulator" type, especially adapted to railway conductors.

Telegraphs :—

Printing Telegraph, P. H. Fisk, 450,228. Filed Oct. 17, 1890.

A system for connecting electrically a series of any number of typewriters at distant points.

Telegraph Relay, R. O. Wickes, 450,272. Filed Dec. 8, 1890.

A relay designed and constructed with special reference to facility of adjustment.

Telephones and Apparatus :—

Auxiliary Mouth-Piece for Telephones, W. N. Marcus, 450,858. Filed Feb. 10, 1891.

An adjustable tube and mouth-piece.

Receiving Telephone Support, W. N. Marcus, 450,359. Filed Feb. 10, 1891.

A bracket support for telephone receivers.

Electrical Apparatus for Reproducing Sounds, J. E. Roulez, 450,426. Filed Oct. 9, 1890.

A microphone.

Consists of a membrane or diaphragm of semi-conducting material, having one terminal conductor connected to it, in combination with one or more insulated blocks, to which the other conductor is connected, these blocks being also of semi-conducting material and secured to and supported solely by the membrane or diaphragm.

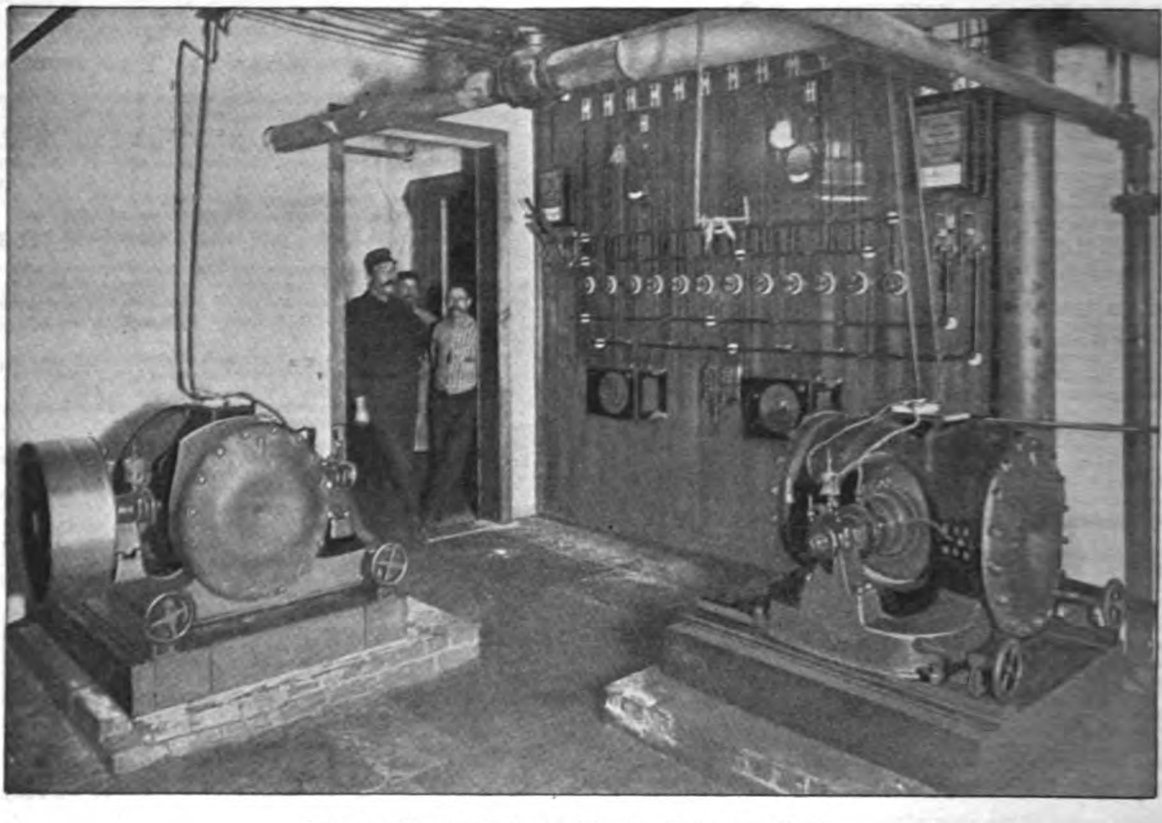
THE ELECTRIC LIGHT PLANT IN THE GENESEE HOTEL AT BUFFALO, N. Y.

It is a noticeable feature, and becoming more and more common every day, that all hotels and large buildings are utilizing electric light with its numerous advantages of cleanliness, better diffusion of light, and ease of manipulation.

One of the finest incandescent light plants recently installed in northwestern New York is that in the Genesee Hotel at Buffalo. This plant is especially noteworthy for its successful and efficient operation, the very thorough manner in which the whole plant has been put in, and the artistic distribution of the lights.

The plant was installed by Messrs. F. P. Little & Co., the well-known constructing and consulting electrical engineers of Buffalo, the contract for the engines and dynamos having been awarded to Mr. P. P. Beals, the New York State agent of the Wenstrom Consolidated Dynamo & Motor Co., of Baltimore, Md., whose electrical apparatus is used.

The generating plant in the Genesee Hotel, which is shown in the accompanying engraving, comprises two Wenstrom, 110 volt, shunt wound dynamos, of 250 lights capacity each, which are belted direct to Rice automatic high speed engines, built by the John T. Noye Mfg. Co., of Buffalo, one of which is 26 h. p., and the other 40 h. p., the latter engine being also used to operate other machinery. Steam for running the engines is supplied by three boilers, placed in a spacious boiler room adjacent to the dynamo room, one of 55 h. p., one of 45, and one of 30, two, only, of which are in general use, the other being a reserve. The elevator, pumps, and steam heat, in addition to the electric plant, are supplied from these boilers.



DYNAMO ROOM, GENESEE HOTEL, BUFFALO, N. Y.

The principal features of the Wenstrom dynamo, it will be remembered, are the iron clad field magnets, where the magnetizing coils are surrounded by iron, preventing loss of the magnetic lines, reducing the amount of wire required to a minimum, and effecting a saving of power; and the embedding of the armature conductors in the core, this permitting of the least interpolar space between the armature and pole pieces, and reducing the amount of magnetization required for any given electro-motive force. The noticeable qualities of these machines, due to the above construction are, quiet running and slow speed. The machines, in fact, make only 570 revolutions per minute, one of the engines running at 280, and the other at 260 revolutions per minute.

The switch-board, which is placed in the dynamo room, is a most thorough and complete piece of work, and is equipped with ammeters, voltmeters, cut-outs and switches. There are twelve circuits at present running to the board, including arc lamp circuits, two "Universal" arc lamps for running on incandescent circuits being employed, the operation of which is highly satisfactory; the lamps give a brilliant and steady light without flickering, hissing or flaming. Each circuit is fitted with double pole switches, and the lights are so arranged that those on any floor can be cut out in the dynamo room at the switch-board Three large, double pole main switches are employed, enabling the dynamo machines to be coupled in multiple, or either one of them placed on one or any number of the circuits.

The circuits are connected to two sets of bus bars, allowing of running in multiple, or dividing the circuits as desired, between the two machines. The well-known tubes of the Interior Conduit system are used for covering the bus bars and wires on the switch-board, making a very neat and effective method of insulating these parts of the system from damages or injury that might occur if run uninsulated. The wiring is most complete, and has been carried out in a most thorough and workman-like manner. The drop in voltage from the centre of distribution is 2 per cent.

The work on the first, second and third floors, and the front portions of the fourth and fifth, is all concealed, "Grimshaw" wire being used throughout, and in the other parts of the plant, where open cleat work has been installed, "Shield Brand" weather proof wire is used. There are also three large and handsome stores in connection with the building which are very attractively and well lighted. On all the circuits and on each floor are placed cut-outs, and the usual safety devices. The two Universal arc lamps which are used for exterior lighting, are run in series between the incandescent mains, and absorb about eight amperes of current, giving a very clear, white, and thoroughly reliable light. "Edison" incandescent lamps are used throughout. This plant is one of the many recent improvements made in the Genesee Hotel, and adds much to its appearance, comfort and attractiveness.

The hotel is at present wired for 700 lights, but it is not unlikely that this number will be increased within the near future. The lighting in the café, bar and rotunda of the hotel, has been especially well carried out, and the lamps are most tastefully and artistically arranged, giving a very beautiful effect and delicate diffusion of the light.

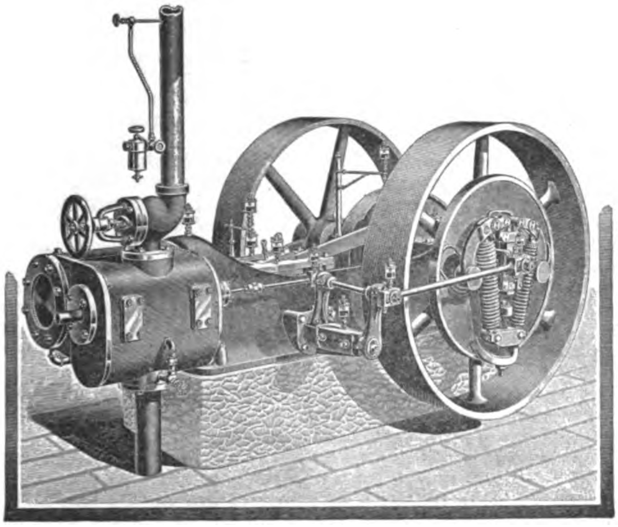
This is but one of the many fine plants which have been installed by F. P. Little & Co. Among others recently put in may be mentioned a 1,000 incandescent light plant for Shea & Co., and a National alternating plant in the John T. Noye Mfg. Co.'s factory. Also a "Wood" 80 light arc machine in the city plant at Penn Yan, N. Y., which has just been started and is giving most excellent satisfaction. The city lighting plant using the Western Electric Co.'s system at New Castle, Pa., was also installed by them, as well as the electric street railway plant there, of the Thomson-Houston system. A 1,000 incandescent National alternating plant of their construction exists at Clyde, N. Y., where they are also building a city arc lighting plant.

TRADE NOTES AND NOVELTIES
AND MECHANICAL DEPARTMENT.

No matter how quickly an industry grows, the persistent advertiser is always in touch with it and he is known to every new consumer.

THE ERIE CITY AUTOMATIC ENGINE.

The Erie City, Pa., Iron Works automatic cut-off engines, illustrated herewith, are made from entirely new designs and patterns. The beds are well proportioned and very strong, and are provided with new patent pillow blocks or main bearings, which have square surfaces with an improved form of gib, to allow for taking up the wear. The gib is adjusted by a set screw tapped through the solid bed, and provided on its inner end by ball and socket joint, to allow for perfect adjustment.



Erie City Automatic Engine.

The steam chest is made detachable from the cylinder. The valve is large and simple in its construction, is provided with water grooves for packing, is accurately fitted, and perfectly balanced. The water packing avoids the use of packing rings or springs, which are more or less liable to get out of order and cause trouble. besides taking a great deal of power to move, and putting unnecessary strain on the governor.

The governor plate is strong and heavily ribbed on the back, and the springs are arranged close to the plate, to avoid undue vibration. The adjusting screw is placed on the same side of the plates as the weights, which brings all the strains in one plane, with the result that the governor is very sensitive and insures close regulation. The eccentric rod is driven from an eccentric pin instead of eccentric and strap. The piston rods are fitted by screwing them into the crosshead with U. S. standard threads, having jam nut to check up behind. This obviates the keying of the eccentric rod and crosshead, which not infrequently causes trouble, when the key is driven too far down. The piston is also secured on the rod by U. S. standard threads, and the ends of the rod are riveted over. The rocker is made with a take-up gib on one side, and has two strong arms through which a steel shaft is passed.

The engine is well built and well proportioned throughout, and careful tests prove it to be one of the best high speed engines now on the market.

B. F. STURTEVANT & CO.

The rapidly increasing business of the Chicago Branch House of the B. F. Sturtevant Co., of Boston, has necessitated its removal to new and much larger quarters at 16 South Canal street, Chicago, where an entire new building furnishes ample accomodations for the large stock of blowers, exhausters, heating and ventilating apparatus, portable forges and steam engines. This branch will remain under the control of Foss & Noble, and will form the headquarters for the trade of the Middle and Western States. The stock will be greatly increased in order to provide for immediate shipment in all cases, and a corps of experienced engineers will be maintained for estimating upon and installing plants for heating, drying, ventilating, etc.

B. & S. INSULATING MATERIALS.

The B. & S. Electric Equipment Co. have recently placed on the market a line of elastic insulating paints, compounds, and waxes suitable for covering line wires, making splices or filling junction boxes and tubes. The pole and cross-arm paints are manufactured solely for this purpose, and are unsurpassed for durability and appearance by any in the market. These paints and compounds embody the results of many years experience of an expert manufacturing chemist in this special line of work.

The favor with which they are being received by telegraph and electric light companies, shows that really good articles of this kind at a moderate price are needed. A list of the material kept on hand is given below, but any special paint or compound to meet special conditions will be manufactured. B. & S. Elastic Hard Black Wax; B. &. S. Black Elastic Insulating Compound; B. & S. Elastic Black Weatherproof Compound; B. & S. Elastic Black Insulating Compound, No. 2; B. & S. Elastic Black Weatherproof Insulating Compound; B. & S. Elastic "White Core" Compound; B. & S. Elastic "White Core" Paste; B. & S. Elastic Clear Varnish; B. & S. Elastic Black Hard Finish, or air drying Elastic Japan; B. & S. Acid and Alkali Proof Varnish; B. & S. Black Telegraph Cross-arm Paint; B. & S. Bright Red Telegraph Cross-arm Paint; B. & S. Quick Drying Telegraph Pole Paint; Black, Dark Bronze, Green, and Medium Bronze Green; B. & S. Linseed Oil Black Priming Paint.

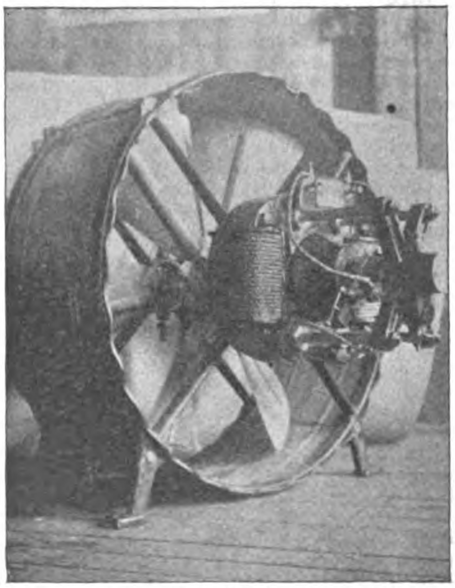
SILICON BRONZE TROLLEY WIRE.

The Aluminum Brass and Bronze Co. of Bridgeport, Conn. have issued a very artistic little pamphlet containing testimonials from electric railways all over the country in praise of their silicon bronze trolley wire. This wire seems to be giving the best of satisfaction wherever used, and is daily growing in popularity.

WING FAN AND RIKER ELECTRIC MOTOR COMBINATION.

The accompanying illustration shows the combined Wing fan and Riker electric motor, now being introduced by the L. J. Wing Co., of 126 Liberty St., N. Y.

All users of machinery concede that in any machine requiring power it is desirable, when possible, to obtain a motive power which will be compact, self-contained, and form a part of the machine to be operated. Especially is this a requisite where the machine to be operated is more or less isolated, as is generally the case with a fan. All these conditions are completely filled by this outfit. Being an electric motor, it is necessary only to wire to the motor. This saves the expense of, and attention demanded by, steam pipes, shafting, belting, and many other objectionable features under the old conditions.



Combined Wing Fan and Riker Motor.

The electric fans may be arranged to run at different speeds, are clean, perfectly rigid and moisture proof, and are constructed throughout in the best manner. They attain, in the smaller sizes, a commercial efficiency of 85 per cent., which increases in proportion to the size of the fan. These outfits have been in use for two seasons with excellent results, and are now about to enter on their third season with important improvements.

THE TAPER SLEEVE FRICTION CLUTCH PULLEYS.

THE subject of friction clutches has become within a comparatively brief period a very important one, and is to-day attracting the attention of all progressive builders and users of machinery; and no mill, factory, or manufacturing establishment is now complete without its friction-clutch pulleys and friction-clutch couplings to connect and disconnect its machines and lines of shafting without stopping or slacking the speed of the engine.

The accompanying illustrations, Figs. 1 and 2, represent the friction-clutch made by the Taper Sleeve Pulley Works, of Erie, Pa.

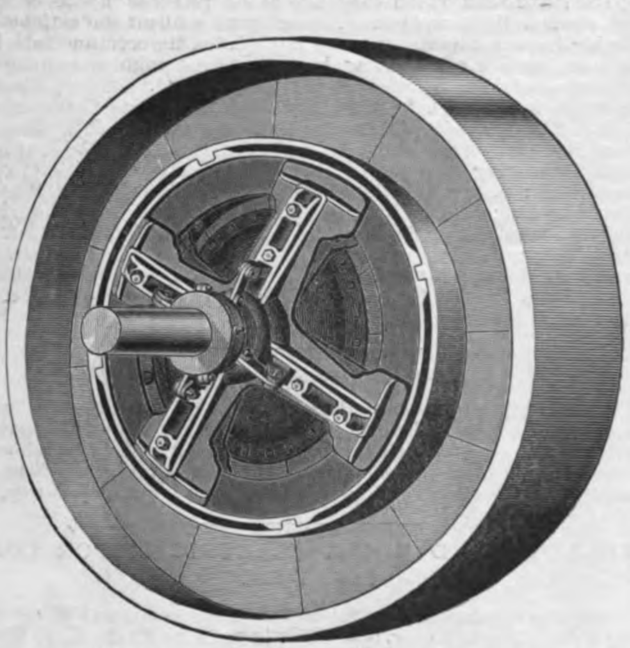


FIG. 1.—TAPER SLEEVE PULLEY CLUTCH.

The web of the pulley is constructed of several segmental pieces, as shown in Fig. 1, in each of which the grain of the wood is in a radial line from centre to circumference, and the rim or face is constructed by building up a series of rings on either side of the outer edge of the web.

As wood does not shrink or swell perceptibly in the line of the length of the grain, and as the grain of the web is disposed radially from the centre and confined by the rim from circumferential displacement—it is impossible for the pulley to get out of shape. These pulleys average from one-quarter to one-third the weight of iron pulleys of similar dimensions.

As shown in Fig. 2, the clutch pulley has a long hub fitted with lubricators, in which the shaft turns when the clutch is disengaged, leaving the pulley, belt and machine at rest. The clutch, which is keyed to the shaft and revolves with it, consists of a vise-like arrangement of iron jaws, the gripping parts of which are shod with maple blocks, which are brought together or closed by compound levers, operated by a toggle-joint cone, and which are so pivoted as to open by centrifugal action, aided by powerful springs, when the cone is thrown out. The action of these jaws may be as gradual as desired, being adjustable at will, and is sure, strong and noiseless.

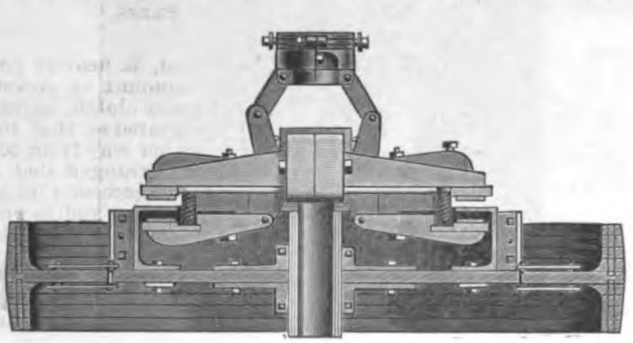


FIG. 2.—TAPER SLEEVE PULLEY CLUTCH.

When it is desired to start the pulley, the cone, which is operated by a shifting lever, is gradually pushed in, and these maple-faced jaws grip the outer and inner faces of the polished friction ring, which is bolted to the web of the pulley, at first slipping and moving the pulley but slightly, and taking hold more and more as the operator pushes home the cone, until a positive hold is attained and the pulley has reached the full speed of the shaft.

A NOTEWORTHY ELECTRIC LIGHT PLANT.

An opportunity was given to electrical engineers recently to inspect the electric lighting plant at the new dry goods store of Messrs. H. C. F. Koch & Co., on 125th street, this city, which is deserving of special mention, on account of the thorough manner in which every detail of the work has been carried out.

The current is generated in the basement, from two Thomson-Houston compound wound dynamos, one of 800 light, and one of 400 light capacity. Each machine is driven by an independent high speed "Ideal" engine of 80 and 40 horse-power, respectively, which, with a separate circuit to every floor, insures light to the building at all times.

Heavy foundations have been provided for this machinery, effectually preventing vibration from being transmitted to any part of the building. The belt centres have been made exceptionally long, with light, noiseless running as a result.

The main switchboard is located in the dynamo room, and is so arranged as to allow the machines to operate together or alone on any or all circuits. It is made of enameled slate and has voltmeters, ammeters, rheostats, switches, and all necessary controlling devices upon it.

The basement has 136 lights—on fixtures in the china and toy department, elsewhere suspended from silk cords. The first floor is lighted by 246 ground glass lamps, placed on beautiful fixtures arranged in seven long rows the length of the store. The show window deserves special mention, being lighted as is no other window of its kind in New York. The lights here are placed against the ceiling, with 12-inch, double glass, reflectors for each light. There are ten lights to each window, making forty in all. These reflectors are the feature of the show window lighting, being made of glass, front and back, the space between filled with a mercury compound, and hermetically sealed. They never tarnish, are extremely bright, and with ground glass lamps reflect a powerful but soft light. These reflectors are manufactured by the Thackara Manufacturing Co., of Philadelphia.

The second floor is lighted by 216 lamps, all on fixtures, as on the floor below, except for a few reflectors in dark places. The lamps on the third floor, 200 in number, are mostly on fixtures, while on the fourth floor 200 silk drops are used, the wiring being on insulators and all exposed.

A good idea of the lighting is given when we state that there are 172 ceiling fixtures, 265 silk cord drops, 41 receptacles, 57 reflector lights, 4 newel fixtures, 3 bracket fixtures; or a total of 542 outlets and 1,007 16-candle power lights.

There are 100 switches, giving absolute and convenient control of all lights. Grimshaw White Core wire has been used, it being placed in mouldings run on the stringers in the air spaces between the floors and iron ceiling. The mains from the basement are run in mouldings placed in position by plugging walls and screwing thereto. They are finished to conform with the surrounding woodwork. All concealed moulding is painted inside and out with P. & B. waterproof paint. All lights are controlled by switches located in the main pocket, one for each floor, where all fuses are also placed.

This plant is simple in its design and construction, and is especially flexible in its control. The work was designed by, and executed under the direct supervision of, the consulting engineer, Charles H. Davis, C. E. The contractors were: Electric plant and wiring, Thomson-Houston Electric Co.; fixtures, The Mitchell-Vance Co.; and engines, W. R. Fleming & Co.

The following summary of apparatus and material will be of interest: One 62,000 watt Thomson-Houston dynamo; 500 amperes at 125 volts, capacity 800 16 c. p. lamps, weight, 10,000 pounds, 900 revolutions per minute. One 30,000 watt Thomson-Houston dynamo; 240 amperes at 125 volts, capacity 400 16 c. p. lamps, weight, 5,000 pounds, 1,174 revolutions a minute. Five miles of "Grimshaw" wire; 74 Thomson-Houston vertical switches; 10 Thomson-Houston knife switches; main switchboard of enameled slate 6 feet by 4 feet; five panel boards of enameled slate with all local switches placed thereon; 1,007 16 c. p. lamps and 542 outlets; 172 ceiling fixture pendants; four newel fixtures; three bracket fixtures; 41 receptacles; 265 silk cord drops; 57 reflectors. The total cost was about $13,000.

CHARGING STATIONS FOR ELECTRIC LAUNCHES ON THE THAMES.

Woodhouse & Rawson United Limited, have arranged for the erection of a permanent charging station on the banks of the river at Chertsey, under the management of Mr. J. Taylor. The station is now in course of erection, and will be quite ready to undertake the charging of all sizes of electric launches by the beginning of the river season. Why would not such a scheme work in New York, in Central Park; and in Brooklyn, in Prospect Park; or even on the Harlem?

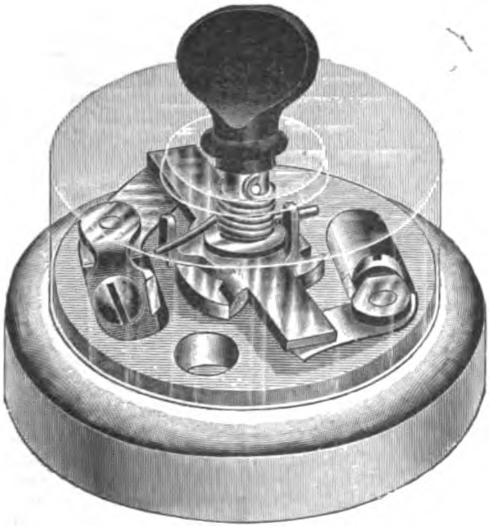
THE BARR CO.'S ELECTRIC CIGAR LIGHTER.

The accompanying illustration shows a form of electric cigar lighter, now being manufactured and handled by the Barr Electric Mfg. Co., of 19 Broadway, New York. The demand for a cheap, reliable and decorative cigar lighter for office or residence use, has given rise to this form of apparatus which seems to "fill the bill" in every particular. The lighter being of the primary battery type, needs no connection with power or light circuits, and therefore has the advantage of being portable. The ornamental case has a glass lining containing the ordinary bichromate of potash battery solution with carbon and zinc elements. When not actually in use the zinc is kept clear of the solution by a spiral spring, the compression of which dips the zinc in the solution, heating to incandescence a platinum strip. While this idea is not entirely new, there is one thing about the device which is new and of the greatest value; heretofore the difficulty has been that the pressure of the cigar or material to be lighted has borne directly, or almost directly, against the incandescent platinum strip, the result being that the strip is soon broken or impaired.

The device shown above is provided with an orifice into which a little alcohol soaked sponge is pressed that does not allow the lighter even to touch the platinum strip, ignition taking place promptly on account of proximity to the fuse of the alcohol. Taken all in all, the device is a happy combination of usefulness and safety with the æsthetic requirements of ornate bric-a-brac. One charge of the battery should last between 30 and 60 days and should cost only about 10 cents.

THE SPERRY SPECIAL SNAP SWITCH, THE "4S."

Mr. Elmer A. Sperry, while supposedly spending all his time in building mining machinery or in engineering problems of like magnitude, seems to find time to develop other inventions, which, though not so pretentious, are quite as useful in their way. His very latest, and one which has not in any manner been referred to before is the "4S" or "Sperry special snap switch," shown in the accompanying illustration. The action of this very novel incandescent switch is different from anything that has hitherto been made. It does away entirely with the dogs or other small parts, the working parts consisting of but two pieces, both of which can be easily seen in the drawing, viz., the spring and lever. The ratchet which controls the movement of the lever forms part of the base of the switch. The double break made by this switch measures more than 1¾ inches, and will break several times the voltage ordinarily used. The action of the lever upon the terminal contact always keeps the contact surfaces clean and bright, and friction, or any other than positive mechanical movements, is entirely dispensed with in the working of this switch.



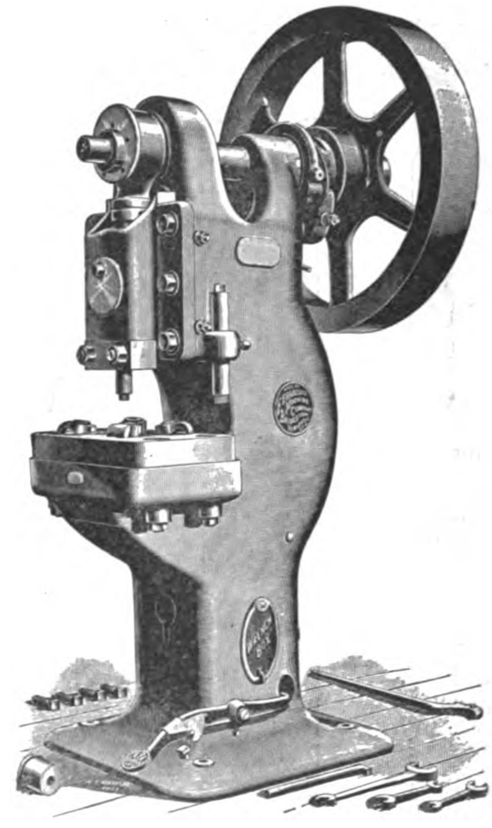
The Sperry 4s Switch.

The handle is so arranged as to unscrew when turned backward for removing the cover, thus giving easy access to the interior. A number of new and special features of construction have been utilized, among them the method of making connection. The terminal is depressed below the surface at an angle so that the screw driver can easily reach it from the top, requiring no extra perforation for the admission of the wires, which are always open to inspection upon simply removing the cover.

This switch is extremely neat in appearance, the base for the 10 ampere size measuring less than three inches over all, and some very remarkable feats have been accomplished by it in breaking large currents at high potentials. On the whole it is one of the most novel and thoroughly practical of the recent developments in the field of electrical supplies. It is manufactured and sold by the Sperry Electric Mining Machine Co., of Chicago.

A NEW PUNCHING PRESS.

The accompanying illustration shows a new style of punching press lately built by the Ferracute Machine Co., of Bridgeton, New Jersey. This press is of new design and has a number of features not embodied in other presses for the same kind of work.



The New Ferracute Punching Press.

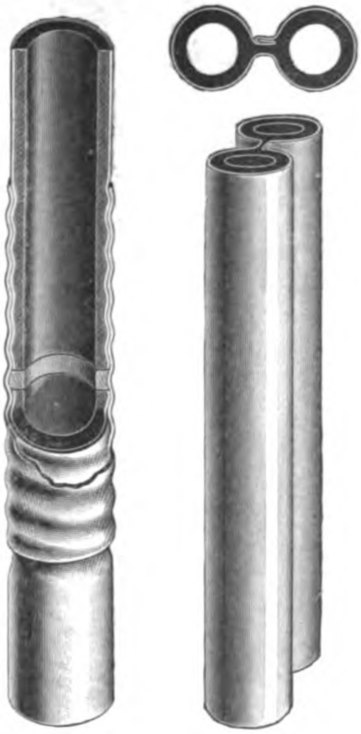
The frame is much higher with more bed-room, is heavier and has a larger fly-wheel, thus giving a greater amount of power. It also has a new form of improved automatic clutch, adjustable for different speeds, and adjustable when geared so that the press may be stopped either up or 30 degrees either way from top of stroke for special work. This clutch is so arranged that it does away with nearly all the friction usually necessary in an automatic clutch, is very durable in its construction, and is provided with a safety-pin, so that it is not necessary to remove the belt when setting dies. It is connected with the treadle, which has a lock arrangement, so that the press can either be run continuously or stopped at each stroke if desired. The fly-wheel has a steel disc with four recesses so that the clutch-slide will engage every fourth of a revolution.

The slide-bar adjustment is of new form so as to vary the height of the ram or slide-bar very considerably, and can be adjusted and locked in a moment. It is graduated so that each degree indicates $\frac{1}{100}$ in height, which is a very convenient feature in setting and recording dies. It can also be used in giving a series of blows with gradually increasing pressure. It has a special form of bolster-plate with sliding-clamps so that almost any dies can be held in it. It also has a new form of stripper-clamps and many other features which are a great convenience and which are not generally embodied in other makes of presses.

These presses are of excellent design and finish and already large numbers of them are in use. There are five sizes. There are also five sizes of corresponding presses with a gear wheel on the main shaft instead of a fly-wheel, and with pinion and fast and loose pulley on the lower shaft, thus giving a slower motion, which is desirable for various kinds of work, and these have about 80 per cent. or 40 per cent. more power. There are a number of attachments which can be used to advantage in these presses, such as pans, shelf, etc., and also shearing and punching apparatus of various kinds. These presses can be used not only for ordinary shearing and punching, but for cutting out blanks, forming them up, and a great variety of other work. They are especially adapted for a great variety of electrical work, such as cutting out and forming up various parts of telegraph instruments, punching and shearing heavy work for dynamos, etc. The general dimensions of the press 53 shown are as follows: Weight without extra appliances, about 3,500 lbs.; height from floor to top of fly-wheel, 83″; hole through bed front to back, 8″; hole through bed, right to left, 10″; stroke of slide-bar, 1½″; weight of fly-wheel, 735 lbs. Other dimensions are given for this press and other sizes in a handsomely illustrated price list issued by the Ferracute Machine Co.

NEW FORMS OF "INTERIOR CONDUIT" TUBING.

We illustrate herewith a new article of manufacture, designed and placed upon the market by the enterprising and energetic Interior Conduit & Insulation Company. The Company has been frequently called upon to furnish a metal covered tube for decorative purposes, extra protection against mechanical injury, absolute fire proofing and protection against deleterious elements of cement. Fig. 1 illustrates the perfection of the metal covered tube. Their well-known interior tube is drawn through a die and an outer covering of either brass, steel or iron drawn upon it, fastened and securely sealed by an ingenious lapping of the seam. The tubes are joined together by their familiar screw couplings. In order to guard against any liability of moisture or condensation, providing a leak to the outer covering of the tube, a pliable washer is inserted between the two abutting ends of the tube. Fig. 2 shows two separate tubes covered with one piece of metal drawn on as the one above described. This double tube will be made in sizes one-quarter and five-sixteenths inch inside diameter, and will be found very useful as a substitute for moulding, and will be used largely for exposed work. It is needless to say that both of the above tubes may be highly polished or finished in any color metal.


FIGS. 1 AND 2.—NEW INTERIOR CONDUITS.

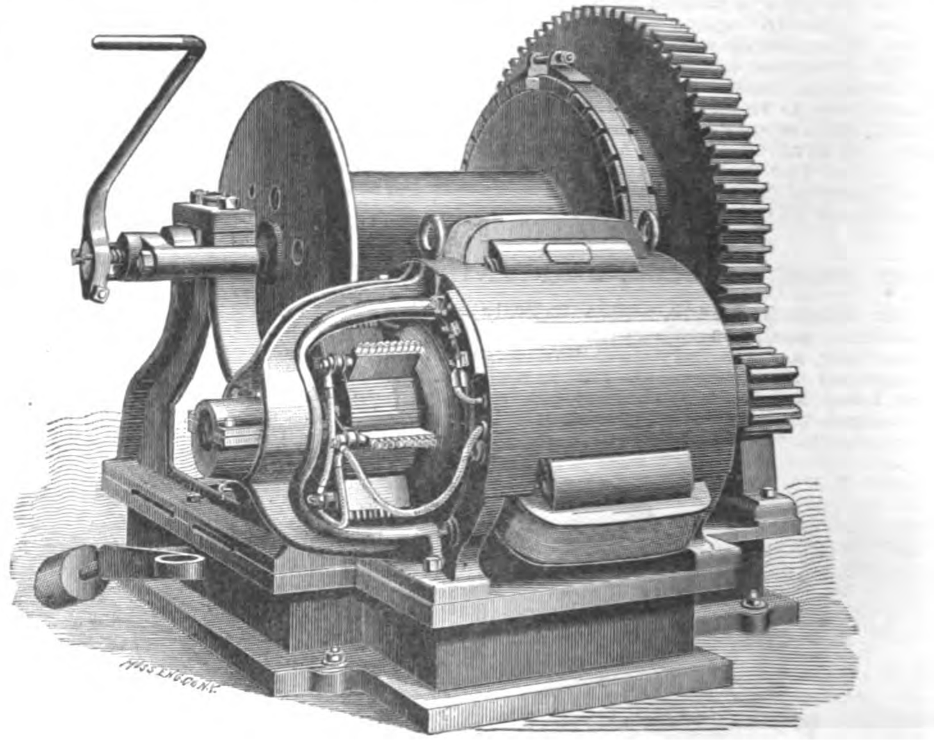
MULTIPLE ELECTRIC GAS LIGHTING APPARATUS.

Mr. A. L. Bogart, 22 Union Square, New York, has just published a pamphlet containing full and explicit instructions for the installation and mode of operating multiple electric gas lighting apparatus. Copies will be mailed to applicants on receipt of twenty-five cents each; in lots of 25 or over, 15 cents each. This pamphlet will interest the most experienced adept, and an amateur can successfully install, and practically operate a multiple electric gas-lighting plant by strictly following the directions contained therein.

PERRET SINGLE REDUCTION ELECTRIC HOIST.

WE illustrate below an Electric Dock Hoist brought out several months since by the Elektron Mfg. Co. This is a piece of machinery where the single reduction and slow speed with which Mr. Perret has been so successful a pioneer, are particularly desirable, on account of the saving in space, noise, friction and consumption of current. The motor is a 15 h. p. Perret multipolar, making 450 revolutions per minute, geared by a gun-metal pinion to a 38 inch gear on the drum shaft of hoist. The drum is 1 ft. in diameter, giving a speed on hoisting rope of a little over 200 ft. per minute.

The motor is shunt wound, and drives the gear wheel at a constant speed, which may be increased, if desired, by the introduction of resistance in the field circuit. By depressing the hand lever the hoisting drum is forced against a friction device revolving with the gear wheel and lifts the load, its speed varying with the pressure on the lever. To lower the load the foot lever is depressed and the hand lever raised. The whole machine is very compact and simple, and is built to stand rough dock usage. The motor is water-proof and has all the latest improvements.


THE ELEKTRON HOIST.

THE HEISLER ELECTRIC LIGHT SYSTEM.

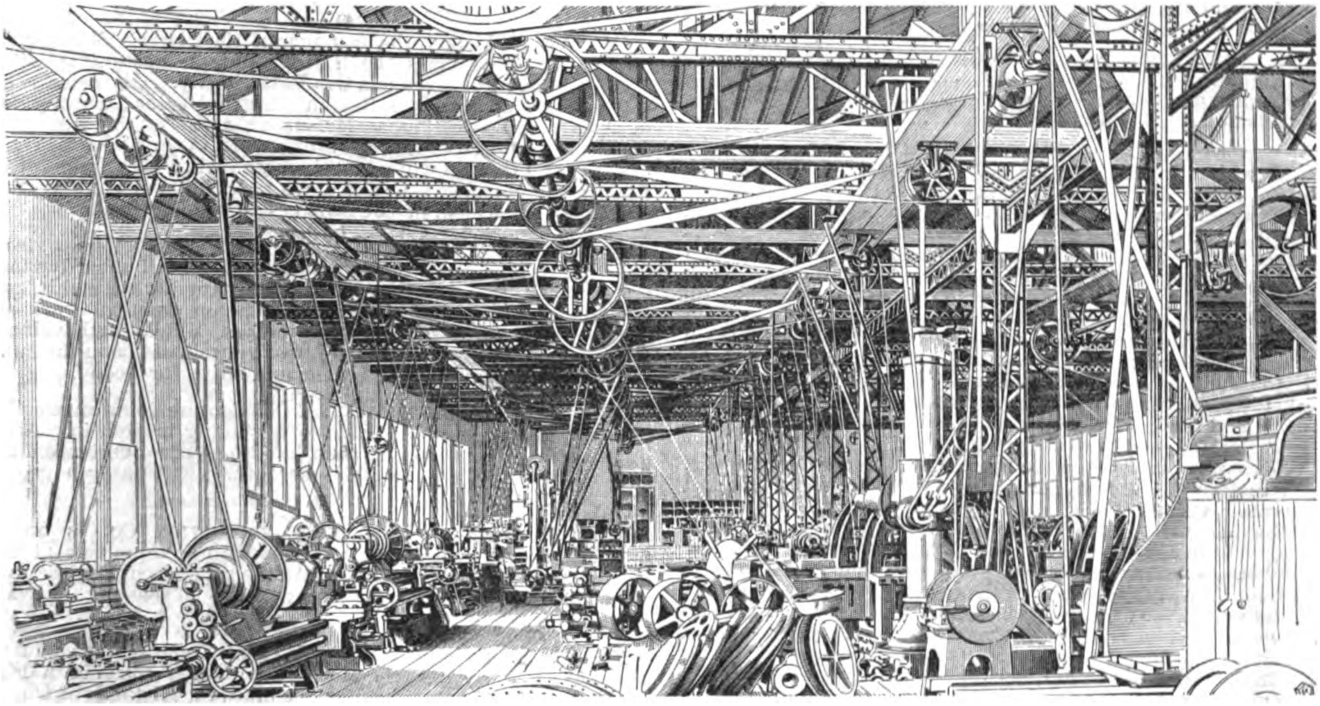
The Heisler Electric Light Co., of Philadelphia, have consummated arrangements with the Interstate Complete Electric Construction Co., of St. Louis, to act as their agents for the State of Missouri and adjacent territory, and also to carry in stock a full line of material and repairs. Practically speaking, they will maintain an establishment to take care of all wants of the Heisler system in their territory. The Heisler Co. have also consummated similar arrangements with Messrs. M. V. Smith & Son, of Belton, Texas, for the State of Texas and a portion of Mexico. These people will conduct an establishment, equipped similar to the Interstate Complete Electric Construction Co. Thus the Heisler Co. are gradually establishing their business at various points in such a manner that users of their apparatus will be thoroughly protected from any unnecessary delay in the receipt of supplies or repairs. They have lately closed contracts for several installations, among them, Bellevue, O.; Marine City, Mich.; Colorado, Texas; Montgomery, Ala.; and extension of plant at Lampasas, Texas; Belton, Texas; and Wauseon, O.; and the outlook for business is very brilliant. As yet they have not completed arrangements for carrying out their lamp shop extension, principally because of their being so driven on their regular line of work.

THE ARMINGTON & SIMS' ENGINE CO.

A very neat and tasteful little folder has been issued by the above company, of Providence, R. I., in which they call attention to a further reduction in the price of their engines, following up the revision of the price list made a year ago. They are now building over 100 different sizes of standard engines from 10 to 500 h. p. They build heavy engines from 70 h. p. to 500 h. p., and compound engines from 100 h. p. to 1,000 h. p. The demand is large and growing for their three cylinder engines for rolling mills and electric power stations, where the sudden and extreme fluctuations of load are very trying to all but the best engines. The last page of this folder gives the names of the various concerns now representing these engines in the different sections of the country.

MACHINE SHOP AT TITUSVILLE, PA.

In the newer central stations it is becoming the practice to use iron largely in the roof construction, and the method has many obvious advantages. The reasons are practically the same as those which bear on the construction of machine shops. As the matter is one of importance to those engaged in electric light and power work, the accompanying view of a new machine shop just put up by the Berlin Iron Bridge Co., for the Titusville, Pa., Iron Co. will be found of interest.



Machine Shop of the Titusville Iron Company.

The building is 70 feet in width by 205 feet in length inside of walls. The roof trusses are made of iron and so arranged as to carry shafting. Along the central portion of the building is a row of iron columns. The trusses are placed 10 feet apart. Where large amounts of shafting are to be carried from the roof, iron trusses are better adapted for the work than wood, as they are stronger and stiffer and there is no danger of their shrinking and swelling from the action of the weather. An iron truss, when placed in position, will stand firmly and carry its load without vibration or deflection.

THE NATIONAL TELEPHONE CO.

The National Telephone Manufacturing Co. is the name of a corporation in Boston, that has been patiently at work, during the past few months, improving its telephones, besides selling to the public its service for short distance lines between house and stable, office and mills, etc. It has just completed the installation of 12 telephones, or stations, in the immense factory of the Portsmouth Shoe Co., at Portsmouth, N. H., connecting directly with the office, all of the different floors and departments. The building is nearly 400 feet long—six stories high. The service enables the superintendent to communicate or talk with every floor, without disturbing any but the station signalled. In one room alone, there are 300 sewing machines operated. Only a personal visit can enable one to realize the difficulties and obstructions that have been surmounted.

THE ALBRECHT ELECTRIC GOVERNOR.

An Albrecht electric governor has been ordered by the Bangor Electric Light & Power Company to be placed in the plant at Veazie. The machine is so constructed that it governs water wheels, dispensing with all labor.

THE ELECTRIC SIGNAL CLOCK CO.

The Electric Signal Clock Co., Harrisburg, Pa., with a capital of $50,000 has been granted a charter. There are 1,000 shares, held by Dr. H. W. Fishel, Dillsburg, York County; John L. McCaskey, Waynesboro, Franklin County; and R. Willis Fair, of Saltsburg, Indiana County. The directors are H. W. Fishel, R. Willis Fair, H. C. Brenneman, York; John W. Holtzinger, Dr. J. W. Ellenberger, Harrisburg; Dr. Walter Pearce, John L. McCaskey, Waynesboro.

A NEW GAS COMPANY.

Recently a movement has been on foot in New Bedford, Mass., to organize a new company for handling and manufacturing the non-explosive and sanitary gas patented by Gen. Eugene de Beauharnais, and now arrangements have nearly reached completion. A new company has been formed between Gen. Beauharnais and the promoters of the proposed Co-operative Electric Company, and in a few days the organization will be complete.

THE MILLER ELECTRIC DANGER SIGNAL CO.

The Miller Electric Danger Signal Company has been formed in Portland, Me., with the following officers: President, William Y. Ober; treasurer, Horace A. Roberts; clerk, Benjamin G. Ward. Directors: William Y. Ober, Horace A. Roberts, Eugene E. Hill, Alonzo H. Whitten, Stephen S. Marsh, Mial W. Chase, George E. Miller. The capital stock is $1,000,000.

UNIVERSAL ARC LAMPS.

The Universal Arc Lamp Co., 16 and 18 Broad street, have received an order for 14 of their lamps to run on the incandescent circuits of the New Jersey Central Railroad terminus in Jersey City. The order was awarded on the merit of the lamps after sharp competition.

Lowell, Mass.—The Bradbury Storage Battery Company has been organized by the election of the following officers: President, E. W. Lovejoy; vice-president, F. W. Puffer; secretary, F. J. Stone; treasurer, P. B. Randlett; directors to act with the above officers, S. K. Dexter, E. S. Moss, J. Y. Bradbury.

THE LOOMIS PLANT, TAMPA BAY HOTEL, TAMPA, FLORIDA.

The electrical plant in the Tampa Bay Hotel was recently installed by the Eureka Electric Company, of 18 Broadwaw, New York, and every care has been taken to make this a model hotel plant in all respects. A number of novelties in electric lighting have been introduced, and a special feature in connection with this plant, is an incandescent night-lamp; one being placed in each of the principal bed-rooms, and so arranged that the occupant can keep it burning all night at such a degree of brilliancy as desired, making it more convenient than gas, and especially desirable in case of sickness, when pure air is of such importance.

All ceiling lights are placed as high as possible, in order to give a better distribution and a more subdued light. The fixtures are arranged for clusters of electric lights, set within a few inches of the plaster, and backed by mirror reflectors. These clusters are controlled by switches set on the casings of the doors, so that a guest may both enter and leave a room while it is lighted. The music room, diningroom, and ladies' parlor are very brilliantly lighted. On the ceiling at one end of the music room is a five point star composed of 50 lamps; at the other end of this room is a large dome, around which there are two circles of lights, thirty in one and twenty in the other, while on the wall, back of the stage, hangs a thirty light crescent, the emblem of the hotel.

The total hotel plant consists of 2,500 lights of sixteen candle power each, distributed as follows:—

Main Building	1,700	Lights
Dining Room	500	"
Kitchen and Servants' Quarters	200	"
Outside Lights and Power House	100	"

The power house is a separate building about 300 feet from the hotel, in which are located the boilers, engines and dynamos. There are three Babcock & Wilcox boilers of 105 h. p. capacity each, and two Logan boilers with a capacity of 60 h. p. each; three 110 h. p. high speed engines made by the Taylor Manufacturing Co., cylinders 18" x 15", and revolutions 270; steam pressure 90 lbs.; five Loomis automatic incandescent dynamos of 500 lights capacity each; and the switch board controlling the entire plant. The foundations for engines and dynamos are laid on a substantial sub-base of concrete, and built of hard burned brick, and Portland cement. The durability and firmness of the foundations will be appreciated when it is known that on a test, a nickel was balanced on edge on each of the three engine cylinders, and the vibration occasioned by throwing on and off a full load was not enough to disturb it.

The dynamos are arranged to run either in multiple or singly, using a method invented by Mr. Osborn P. Loomis, and covered by patents. On the top of each dynamo, is placed a transfer switch having three contact points, to run the dynamo in multiple, singly, or to cut it out altogether. The arrangement of "bus" bars and cables is such that when running machines in multiple, the output of one machine passes through the series coil of the next, and by the use of the switches, on top of the dynamos, any two or more machines may be run in multiple. Any dynamo can be cut either in or out of multiple, without, in any way, changing the voltage. No rheostats or other regulating devices are used by the Loomis system, as the dynamos are absolutely automatic and require no hand-regulation. The connections from dynamos to switch-board are made by soft-drawn bare copper bars run through porcelain insulators.

The switch-board, which is made of mahogany, contains five Loomis ampere meters, one Loomis automatic ground detector, one direct-reading Weston voltmeter, one seven-point voltmeter switch, and 12 plug circuit switches. The cables from the switch-board to the hotel are run underground in a special conduit, and consist of six circuits of 4/0 cable. The "drop" between dynamos and the farthest lamp, with full load, is 8%, and the difference in potential between any two lamps does not exceed one volt.

Besides the lighting plant, the Eureka Electric Company has installed all the electric bells; furnishing a 400 drop annunciator, made of mahogany and beautifully carved. The wiring has been done in such a manner that at any future time, telephones can be substituted for call bells.

Grimshaw "white core" wire has been used throughout for electric lighting, and, including the bell work, over 60 miles of wire have been used in the installation of this plant.

The Tampa Bay Hotel is the only fire-proof hotel built for the Southern season or tourist travel in the United States, and is most sumptuous and liberal in its appointments, accommodations and furnishings. It was designed by J. A. Wood, of New York, architect of several other season resort hotels, both North and South.

HABIRSHAW WIRES AND CABLES.

The Engineering Equipment Company have become Eastern agents for the well-known Habirshaw wires, cables and cores. The Habirshaw flame-proof wire is attracting considerable attention, especially as the new Underwriter rules require its use. Now that the India Rubber and Gutta Percha Insulating Company, who manufacture exclusively the Habirshaw wires, have secured a new and fine factory at Yonkers, the output of this wire will be increased materially by the facilities afforded by the new works.

As the Engineering Equipment Company advertise in this issue, their offices will be found, from about May 1st, in the "Central Building," No. 143 Liberty street, N. Y. City, but the stock room for Habirshaw wire and Underwood belts will be continued at 78 Cortlandt street, which has been the temporary office of this new company.

THE STANLEY TRANSFORMERS.

An extremely tasteful and pretty pamphlet descriptive and illustrative of their transformers has just been issued by the Stanley Electric Mfg. Co., of Pittsfield, Mass. These transformers were lately brought to notice in our pages, and are already in active demand. At present they are made in six sizes, varying from 5 to 100 lamps, and larger sizes can be had if inquired for. The converter is shown in a couple of excellent woodcuts, which, like the pamphlet itself, are the production of Bartlett & Co., the engravers, of this city.

WESTERN TRADE NOTES.

Mr. W. R. Mason, the manager of the Electric Merchandise Co., of Chicago, reports the Spring trade as opening up with a rush. He expects to make a trip East shortly. His recent election as president of the Burton Electric Heater Company, is a most excellent selection, as Mr. Mason is one of the most wide-awake, shrewd and energetic business men in the electrical trade, but it is said that he will meet his match when Mr. Mason, of the Electric Merchandise Co. goes down to Richmond, Va., to make a deal with Mr. Mason, of the Burton Electric Heater Co.

The Bain Electric Mfg. Co., of 47 and 49 S. Jefferson street, Chicago, have issued a very complete catalogue of their dynamos and motors; in fact, it goes considerably further than this, as it contains a vast amount of information on practical work and the operation of dynamos and motors, simple and valuable formula and highly useful tables. A copy should be in the hands of every electrical man, and all should write for a copy.

The Electrical Supply Co., of Chicago, are doing an excellent business, and the Spring trade is beginning to pour in. About June 1st they will remove to their handsome new quarters on Randolph and Michigan avenue, where they will carry a greater stock than ever.

The Continental Electric Construction Co. is one of Chicago's new electrical organizations with headquarters at 1118 Chamber of Commerce building. As their name implies, they will pay special attention to the constructing of electric railways, light and power plants.

Mr. G. A. E. Kohler, the Western representative of the well-known Eddy Electric Motor Company, is placing a large number of their highly popular machines for all kinds of work.

The Central Electric Co., with their usual enterprise, have just secured the General Western Agency for the New York and Ohio Company's lamp, made at Warren, Ohio. This is the celebrated Packard lamp that is so favorably known among consumers, and is considered by practical men to be one of the very best incandescent lamps yet produced. The new American ammeters and voltmeters, lately described in these columns as among the Central Electric Company's new specialties, are now ready for delivery. They are put up in a handsome box with a handy carrying strap and present an elegant appearance. The published price list shows the instruments to be so low in cost that every one connected with an electric plant of any importance can have one.

Mr. J. W. Freeman, of Joplin, Mo. is manufacturing dynamos and motors in his foundry in that city. The system is one invented by a Mr. Lowe, who is associated with Mr. Freeman, and the machines thus far produced by them have given entire satisfaction.

Mr. W. L. Browne, of Plattsmouth, Neb., is making a tour of inspection of the towns bordering Puget Sound, with a view to starting an electric equipment factory.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

Vol. XI. APRIL 29, 1891. No. 156.

COST OF ELECTRIC POWER.—COMPARATIVE EFFICIENCY OF LARGE AND SMALL MOTORS.

BY

S. S. Wheeler.

THE comparison of efficiencies for motors of different sizes has not been given much prominence, the demonstration of the advantages of power transmission of electricity over any other means having so far absorbed much of the spare time of engineers. The subject of the comparison of sizes is nevertheless of great and growing importance, since in practice it determines some important points, among them, the varying rates of charge for large and small power, the best size of machine for use, etc.

Amperes Required to Give Different Powers on The Various Constant Potential Circuits, Allowing For The Ordinary Efficiency of Each Size of Motor.

(*Copyrighted*, 1891, *by The Crocker-Wheeler Electric Motor Co.*)

Horse-Power of motor.	Efficiency of motor.	Elect. h. p. required	8 volts. battery.	50 volts.	75 volts.	100 volts.	110 volts.	120 volts.	220 volts.	240 volts.	440 volts.	500 volts
1/16	40%	.16	14	2.3	1.6	1.2	1.1	1.	.53	.48	.26	.23
1/8	55	.23	21	3.4	2.2	1.7	1.5	1.4	.76	.69	.38	.34
1/6	60	.28	26	4.1	2.8	2.1	1.9	1.7	.95	.87	.48	.41
1/4	62	.40	38	6.0	4.0	3.0	2.7	2.5	1.4	1.3	.68	.60
1/2	66	.76	71	11.3	7.5	5.7	5.1	4.7	2.6	2.4	1.3	1.13
1	72	1.4	130	20.7	13.8	10.4	9.4	8.6	4.7	4.3	2.4	2.07
2	75	2.7		39.8	26.6	19.9	18.1	16.5	9.1	8.3	4.5	3.98
3	78	3.8		57.3	38.2	28.6	26.	23.8	13.0	11.9	6.5	5.73
4	79	5.0		75.5	50.3	37.7	34.3	31.4	17.2	15.8	8.6	7.55
5	80	6.2		93.3	62.2	46.6	42.4	38.8	21.2	19.4	10.6	9.33
7½	82	9.1		136.	90.9	68.2	62.	56.8	31.0	28.4	15.5	13.6
10	84	12.		178.	118.	88.8	80.7	74.	40.4	37.	20.2	17.8
15	85	17.6		263.	176.	132.	120.	110.	60.	55.	30.	26.3
20	86	23.		347.	231.	173.	158.	145.	79.	72.	39.9	34.7
25	88	28.		424.	283.	212.	193.	177.	96.	88.	48.2	42.4
30	88	34.		509.	339.	254.	231.	212.	116.	106.3	57.8	50.7
35	89	40.		587.	391.	293.	266.	244.	133.	122.	67.4	59.
40	89	45.		671.	447.	335.	305.	280.	153.	140.	77.	67.
50	90	55.		829.	553.	414.	377.	346.	188.	172.	94.	83.
75	90	83.		1243.	828.	621.	565.	518.	283.	259.	141.	124.

The accompanying tables, prepared by Prof. F. B. Crocker and the writer, show at a glance the average practical commercial efficiency of motors of all sizes, and the amounts of current required by each when running at full load upon any of the standard circuits.

As a preliminary to all calculations of current consumed it is, of course, necessary to fix upon a definite efficiency for each size of motor, and the efficiencies here given are a general average, based upon the opinions of the leading experts of several motor companies, obtained by us from time to time with a view to preparing an honest table. The efficiencies will undoubtedly seem low to a great many. They certainly are much lower than the results claimed by nearly every manufacturer of electrical motors, but in placing them at the figures given, we have intended to allow for the performances of machinery under the average conditions of long continued use, taking into consideration the effects of overload and underload, abuse, dirt, etc. As the power consumed is subject to constant variation in most cases, motors in operation are seldom working at that rate at which they are most economical. Hence the efficiencies should be placed a little low in a table which aims to hit the results most frequently obtained in actual practice.

The efficiencies of arc circuit motors, are placed lower than those on constant potential circuits for several reasons. Arc motors are usually run with a regulator, which cannot be quite as economical as the regulation of the constant potential machine. The current of the arc motor, being always at the maximum, the loss by resistance (C^2R) is always at a maximum, even when the motor is running with light load. Again, the disturbances due to considerable fluctuations of the current (not found in constant potential circuits) cause slight losses.

In the tables the number of amperes given for incandescent or constant potential motors shows the current required to give the stated mechanical horse power in each case, and the number of volts given in the table of arc circuit or constant current motors, represent the E. M. F. required at the terminals of the motors to give the same power. Both sets of figures are obtained by calculation from the electrical horse power, allowing for the average of efficiency of each size of motor. The formula used in both tables is as follows;

$$\frac{746}{\begin{array}{c}\text{Amperes of an "arc" circuit}\\ \text{or}\\ \text{volts of an incandescent circuit.}\end{array} \times \begin{array}{l}\text{Efficiency of the motor,}\\ \text{expressed as a decimal}\\ \text{fraction.}\end{array}} = \begin{array}{c}\text{the amount given}\\ \text{in table.}\end{array}$$

An examination of the table shows that the efficiencies range from 40 to 90 per cent., which, compared with the steam engine, shows considerable superiority. The consumption of coal in steam engines of various sizes and types, varies from 2 to 10 lbs. per horse power hour, a variation of 1 to 5 against 1 to 2 with electric motors. Further consideration shows that the amount of energy required to produce a given amount of power is not affected by the size of the motor, within moderate limits; the gain in efficiency, if an unnecessarily large motor is used, being about offset by the losses due to its not being fully loaded. For instance, if 1 h. p. is obtained from a 2 h. p. motor, the motor itself, being larger, will be of slightly greater efficiency; but not being run at its best load the result will be only about the same as if a 1 h. p. machine were used.

In other words, for any given amount of power consumed, the amount of energy required, and, therefore, the cost of running, is practically constant and independent of the size of the motor used, within the ordinary limits of selection. This, however, refers merely to the cost of current and is not to be understood as lessening the imperative importance, for mechanical reasons, of choosing a motor with a considerable margin of capacity.

VOLTS REQUIRED TO GIVE DIFFERENT POWERS ON VARIOUS ARC CIRCUITS, ALLOWING FOR THE ORDINARY EFFICIENCY OF EACH SIZE OF MOTOR.

(*Copyrighted* 1891, *by the Crocker-Wheeler Electric Motor Co.*)

H. P. of motor.	Efficiency of motor.	Electrical h. p. required.	3 amp.	6½ amp.	10 amp.	18 amp.
1/16	35%	.18	44.	20.	13.	7.
1/8	50	.25	62.	29.	19.	10.3
1/4	55	.45	113.	51.	34.	18.7
½	62	.81	201.	93.	60.	33.5
1	68	1.47	366.	169.	110.	60.9
2	72	2.8	696.	319.	207.	115.
3	76	4.0	981.	453.	294.	163.
4	77	5.2	1291.	596.	387.	215.
5	78	6.4	1594.	736.	478.	265.
7½	79	9.5	2360.	1089.	708.	393.
10	80	12.5	3108.	1435.	933.	518.
15	82	18.3	4548.	2099.	1364.	758.
20	83	24.1	5991.	2765.	1797.	999.
25	84	29.8	7400.	3416.	2220.	1233.
40	85	47.1	11700.	5400.	3510.	1950.

TESTING STEEL AND IRON.

A SWEDISH engineer has recently applied electricity to testing steel and iron for its hardness. It is well known that an electric current of sufficient strength will fuse a thin slip of metal or wire when passed through it. By making a number of experiments the engineer has founnd the strengths of current required to fuse test pieces of iron and steel of different degrees of hardness, and has formed a scale of currents corresponding to a scale of hardness. In order to find the hardness of a particular test piece of the metal it is only necessary to find the current required to fuse it, and this can easily be done by means of an amperemeter. The corresponding figure on the scale gives the hardness of the piece.

THE NEW EDISON DIRECT CONNECTED TRIPLE EXPANSION ENGINE AND GENERATOR.

THE inauguration of the first Edison central station in Pearl street, New York, in 1882 may be said to have firmly established the system of electrical distribution from a centre, which has now grown to be one of the greatest industries in the world. This station embodied not only many original ideas in the generation and distribution of the electric current, but, in more than one way, embraced principles of mechanical operation which have since been proved by experience to be correct and conducive to the highest economy in operation. Mindful of the fact that every step in the transmission of the power of the engine to the shaft of the dynamo must necessarily involve some loss, Mr. Edison at that early date appreciated the benefits to be derived from the direct connection of the engine to the shaft of the armature. To this must be added the consideration of the space occupied by, and money invested in, counter shafting, belting, etc., which in large stations will readily be recognized as involving a large outlay in capital, in addition to the fixed charges required for their maintenance. These considerations, with many others, led Mr. Edison to the construction of his historical "Jumbo" machines driven direct by the Armington & Sims and also the Porter-Allen steam engines. Although these machines might be crude in the light of the present day, the solidity of the design was even then such that not a few of these early machines were until quite recently in successful operation in this city in their original position, and a number of them are still successfully at work in the large Edison station in Milan, Italy. Although this original practice of direct connection was departed from later on, the fact has, within recent years, again forced itself upon engineers that central station practice, in order to obtain the highest commercial efficiency, requires thorough economy in every detail and especially in the generating plant. Indeed, we may divide every system of distribution under practically four heads: the engine, including the boiler; the dynamo; the conductors; and the lamp or motor. As the efficiency of the lamps, conductors and dynamos, may be said to be a fixed quantity which can be well calculated out beforehand, it is evident that the success of the plant must be largely dependent upon the engine as the prime source of power and the method of its connection with the dynamo. If, with direct connection, therefore, an engine be employed giving the greatest output with the least consumption of fuel under the boiler, the ideal conditions of economical distribution will have been reached.

The recent advances which have been made in engine building, therefore, ought to find one of their principal applications in the generation and distribution of electricity, and it is with this in view that the Edison General Electric Company have applied the most improved form of engine in a manner calculated, we believe, to have a most marked influence on the future central station practice of this country. Briefly stated, the Edison Company propose to build their compound triple expansion engine not only for generators of the largest type, but also for those of the smallest capacity practicable with this type of engine, thus making each type a unit with engine and dynamo directly connected. In employing the direct method of driving it is evident that the machine must be designed for the speeds practically obtainable under these conditions, and for this purpose evidently the multipolar dynamo is the most suitable. The general design for the larger type of this combination is shown in the accompanying engravings, Figs. 2 and 3, which show a front and side elevation of what is known as the 2-75 kilo-watt type, in which two 6-pole generators are employed, attached to either end of the main crank shaft, driven by a three-cylinder triple expansion condensing engine. Another type of this combination is illustrated in Fig. 1, which gives a view of the machine now erected in the central power station at the Schenectady works of the Edison General Electric Com-

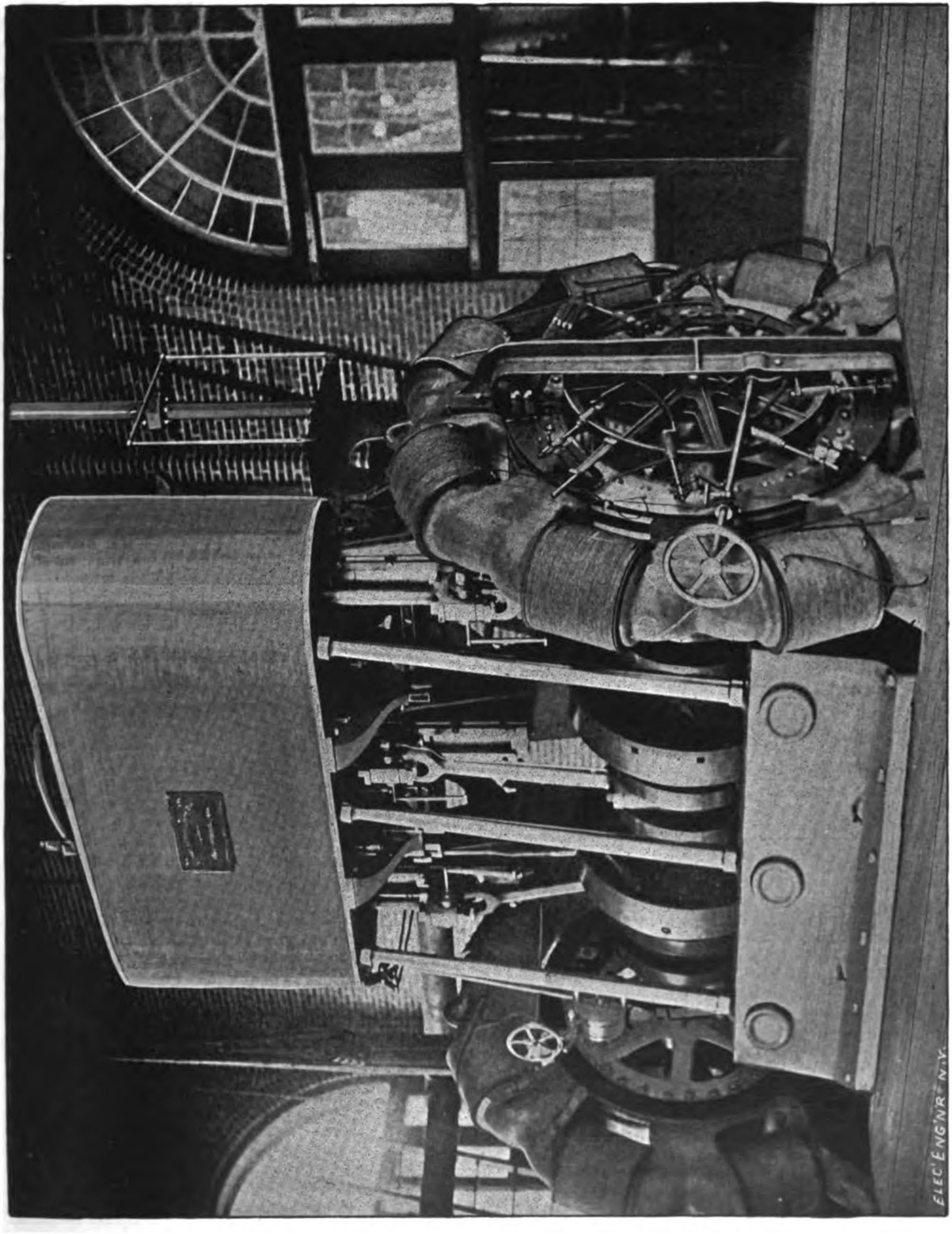
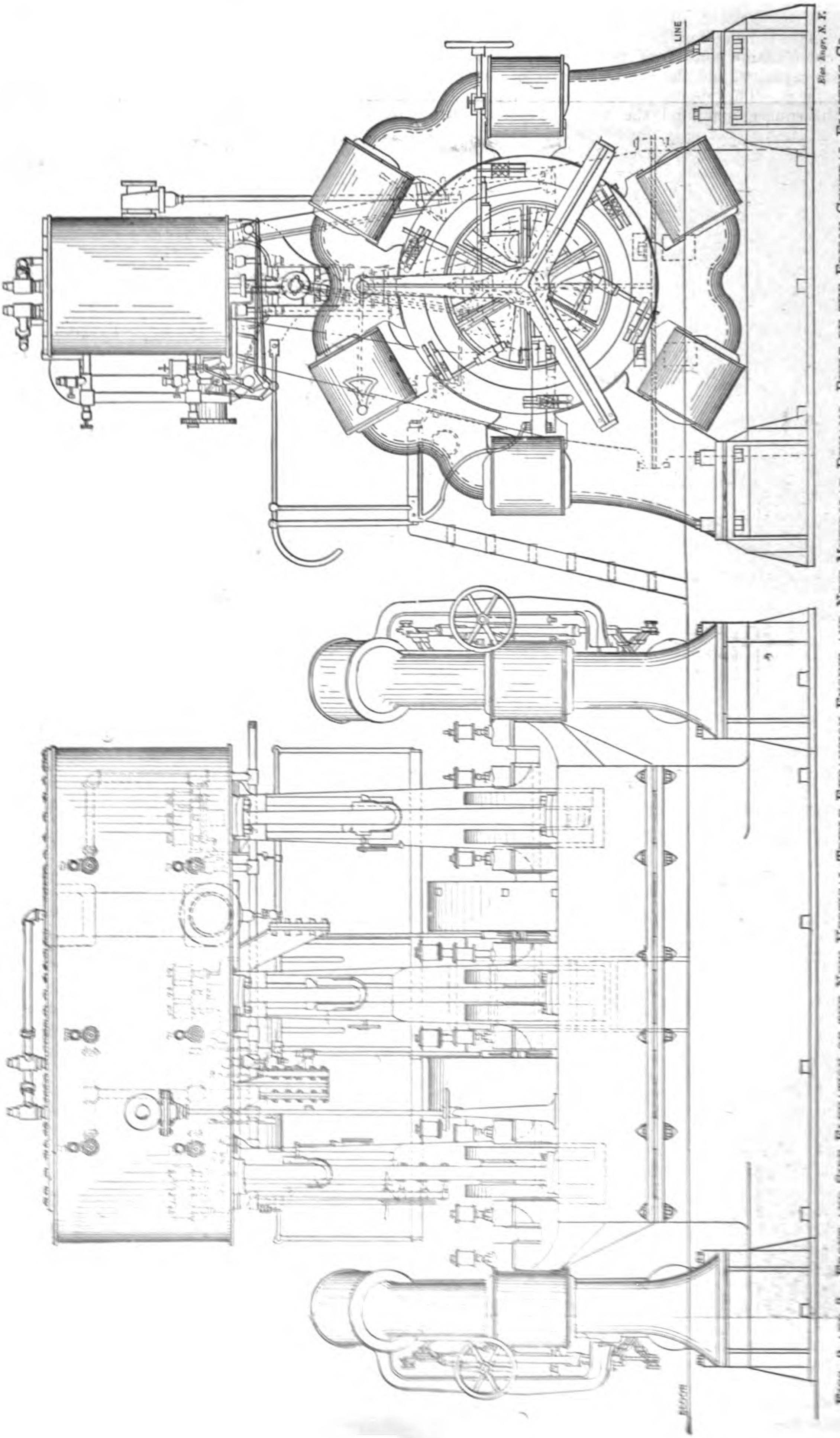


FIG. 1.—COMBINATION OF EDISON GENERAL ELECTRIC CO.'S NEW TRIPLE EXPANSION VERTICAL ENGINE AND NEW EDISON MULTIPOLAR GENERATORS:—OVER 300 H. P. CAPACITY.



FIGS. 2 AND 3.—FRONT AND SIDE ELEVATION OF THE NEW VERTICAL TRIPLE EXPANSION ENGINE AND NEW MUTIPOLAR DYNAMO, BUILT BY THE EDISON GENERAL ELECTRIC CO.

pany, from which station all the shops included in the works will obtain current for the motors driving the shafting. This combination consists of two dynamos, each of 100 kilo-watt capacity, and the engine capable of working to over 300 h. p. The steam pressure employed is 160 pounds to the square inch, and the three cylinders have the following diameters: high pressure, 11⅞ in.; intermediate pressure, 17½; low pressure, 28¼ in. The stroke of the piston is 21 inches, and the engine and armatures make 176 revolutions per minute, giving a piston speed of over 600 feet. Double ported piston valves are employed, one valve to the high pressure cylinder, and two each to the intermediate and low pressure cylinders. The valves are of hard cast iron, turned and ground to fit hard cast iron bushings secured in the valve chest. Crank shaft governors of special design are employed, and the governors are so arranged that the speed can be adjusted as required. Being designed for central station practice, the lubrication of the engine has been thoroughly worked out so that the engine is adapted for continuous uninterrupted running.

We come now to the generators. In this type, it will be noted, the armature rotates within a field magnet having 10 poles. The frame of the field magnet consists of but a single casting, and a very ingenious method has been designed by Mr. Edison for winding on the magnetizing coils. The Gramme ring type of winding is employed, but instead of using coils of a number of convolutions connected to each segment of the commutator, in this type of machine each convolution is connected directly with the commutator bar. For this purpose bare copper strips of U-shape are slipped over one side of the core, insulated from one another, and each succeeding U-shaped bar of this character is connected direct by a commutator bar. The brushes, it will be noted, bear upon the commutator in a vertical plane. This construction with bare conductors is permissible on account of the very small difference of potential, 1¼ volt existing between each bar. The number of bars employed in this type of machine is 944, and hence an equal number of commutator bars is employed. Each bar is therefore equivalent to a coil of the usual type of Gramme winding, but the absence of contiguous layers entirely avoids self-induction and hence sparking, the machine operating without the slightest indication of such a disturbance. Eight brushes are employed, which can be shifted simultaneously by means of the hand-wheel shown, and which can also be lifted at once from the surface of the commutator. The resistance of the armature is .006 ohm, and that of the field 8.45. Each dynamo is designed for 150 volts pressure and a capacity of 666 amperes. The design has been so well worked out that a variation of ¾ of a load can be made without requiring the slightest change in the position of the brushes.

As stated above, besides the machines already constructed, it is proposed to extend this type over the entire range of available sizes; thus designs are already completed for combinations of 2-25, 2-50, 2-75, 2-100, 2-150, 2-200, and 2-400 kilo-watts, in all of which the triple expansion type of engine will be employed. This type of combined engine and dynamo will probably be employed in the new Edison station in New York, where no less than fourteen 2-400 kilo-watt generators will be placed. In the same way the Cincinnati station will be equipped with ten 2-400 kilo-watt generators. The station about to be erected in Milwaukee for lighting and electric railway purposes will contain five 2x200, five 2x50, and twelve 2x100 kilo-watt generators. At Easton, Pa., three 2-100 kilo-watt generators will be erected. In the power station at the Schenectady works of the Edison Company, above mentioned, there will eventually be erected two 2-50, two 2-100, and two 2-200 kilo-watt generators. The new Edison building in this city will also have two 2-25 generators of this type. It is not difficult to foresee the effect which the adoption of high economy generating apparatus of this type will have on the future operation of central stations. It has long been recognized that greater economy is desirable in station operation, and we believe that the methods above pointed out will place the central station operator at once in a position to obtain the maximum output of current with the least consumption of coal.

RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.

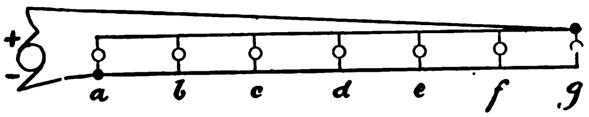
BY

George P. Wardell

The Electrical Engineer for April 15, contains a note by Osborn P. Loomis under this head, correcting an error on the part of Carl Hering, and stating that no system of wiring could be divised which would give the same potential at all the lamps fed by it.

One arrangement, at least, suggests itself which is theoretically perfect, and which would, under some circumstances, be commercially economical. It is as follows:—

In the accompanying figure assume the distance between the lamps *a* and *b* as unity and make the cross section of the positive wire between them the unit of cross section for this problem. Make the positive lead between each pair of lamps, as *e* and *f*, equal to the product of the distance between them into the number of lamps (5) to which it is to carry current, and the negative lead equal to the product of the same distance into the number of lamps (2) from which it is to carry current.



Uniform Pressure on Lamp Leads.

HYDROCHLORIC ACID IN BICHROMATE BATTERIES.

BY

Chas. J. Reed

In The Electrical Engineer of April 22nd, Mr. Chas. Steinmetz advocates the use of hydrochloric acid in bichromate cells. Permit me to call attention to the chemical reactions that must take place.

It is well known that hydrochloric acid or any soluble chloride added to an acid solution containing chromic acid or any soluble chromate, reduces the chromate to a chromic salt with evolution of free chlorine and water, as in the following equation:

$$2H_2CrO_4 + 12HCl = Cr_2Cl_6 + 8H_2O + 6Cl.$$

If sulphuric acid is present in sufficient quantity, only half the amount of hydrochloric acid in the equation will be required, and chromic sulphate or a chrome-alum will be formed. The chromic salts formed in a battery are all inert (so far as zinc and nascent hydrogen are concerned), waste products. The only advantage that can result from the use of hydrochloric acid is the evolution of chlorine at the expense of the chromic acid. The advantage of free chlorine in a battery seems to me doubtful, and its preparation by the action of a chromate on a chloride is, at least, expensive.

THE SOLUBILITY OF MIXTURES OF ELECTROLYTICALLY DISSOCIATED SUBSTANCES.

The principles which regulate the influence of two salts upon the solubility in water of each other are those which can be deduced from the general law of mass action as interpreted in the light of the electrolytic dissociation theory; this has been demonstrated by Nernst, and the subject has recently received further attention from A. A. Noyes, another German chemist. Eleven pairs of salts were carefully examined, and the results of the experiments seem to show a very fair agreement with the values deduced from theory. Most of the investigations were carried out with binary electrolytes, but a few tertiary electrolytes were shown to yield results equally in harmony with the theory. Experiments were made not only with pairs of salts containing one ion in common, but also with pairs of salts the ions of which were all different. Noyes considers that reckoning back from the solubilities it is possible to calculate the dissociation constants of strong electrolytes. If this is a fact, it is one of considerable importance, for the ordinary method of calculation from the electrical conductivity fails in such cases to give a constant number at all. The details of the experiments and the results, etc , for the 11 pairs of salts examined are given in full in the original paper for which pages 241—267 No. VI. of the *Zeitschrift für Physikalishe Chemie* must be consulted.

SUPERIMPOSED MAGNETIZATIONS.

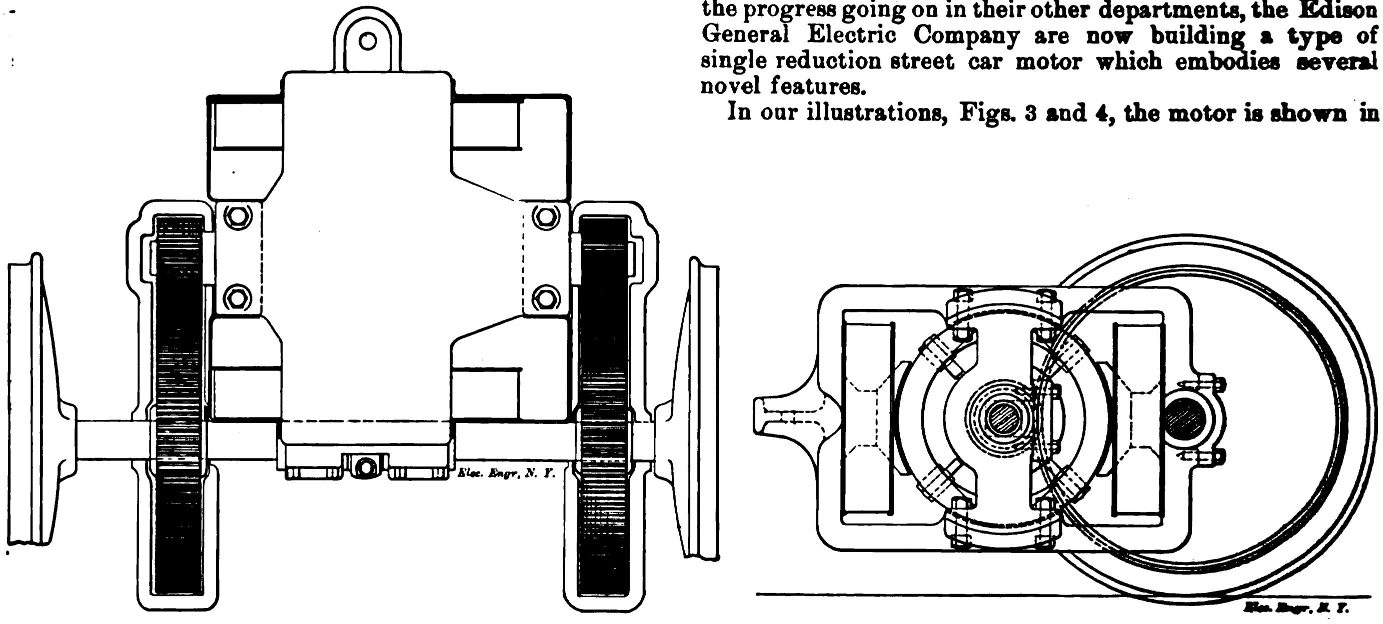
Experiments by M. Jamin have shown that two longitudinal magnetizations of inverse polarity may be imposed on a piece of steel without mutual neutralization. The same has been shown by M. Decharme to be true for transverse magnetization; and in a recent communication to the Académie des Sciences, M. Decharme describes the result of magnetizing the same piece of steel successively, longitudinally and transversely. The specimen of steel was 100mm. long, 28mm. broad, and 3mm. thick. If the conditions were favorable and care was taken, it was found possible to obtain an iron-filing sketch, showing two simultaneously existing magnetizations. In most instances, however, the two magnetizations were merely superimposed, and by making the proper passes the longitudinal and the transverse magnetizations could be made to predominate in succession, and with increasing strength, until saturation point was reached. A bar magnetized first longitudinally and then transversely, would thus appear to be in a state of magnetic instability.

THE EDISON NEW SINGLE REDUCTION STREET CAR MOTOR.

Although the application of the high speed electric motor conveying power to the car axle by a double reduction gear has demonstrated beyond question the practicability and economy of electric railroading, it has become evident that improvement could be effected by the elimination of some of the gearing heretofore employed. The modification necessary to accomplish this purpose, readily suggests itself in the reduction of the initial speed of the motor and the employment of a single reduction only between the motor and the car axle. As the power of the motor is the product of the torque into the speed, the application of the slow speed motor necessitates a construction such that the torque of the motor shall be increased in the same proportion as its speed is reduced. This is best carried out in the multipolar machine, and in keeping with the progress going on in their other departments, the Edison General Electric Company are now building a type of single reduction street car motor which embodies several novel features.

In our illustrations, Figs. 3 and 4, the motor is shown in prospective as seen from either end of the armature, the gears being removed from the shaft in Fig. 3 in order to expose the commutator and brush arrangement. The more detailed construction of the motor is shown in Figs. 1 and 2, from which it will be seen that the machine is of the four-pole type and practically iron-clad. Only two poles, those in the horizontal plane, are wound, the two in the vertical plane being magnetized by induction from the same spools and forming, as it were, consequent poles of opposite polarity. The entire field, consisting of special soft cast-steel, is made in one casting with the exception of the pole pieces which are attached by screw bolts after the spools have been slipped on over the straight cores at the sides. These pole pieces, it will be noted, extend for a short distance beyond the field coils, and practically 80 per cent. of the whole spool is surrounded by iron. As a result of this construction and the employment of cast-steel, the magnetizing force required to attain the proper degree of magnetization is small, and from the nature of the construction there is very little stray magnetism.

The magnetizing coils are wound in three sections on vulcabeston spools, which, as stated above, are slipped on over the cores. In the construction of the machine the facing of the armature bearing and the cylindrical arma-



Figs. 1 and 2.—Side Elevation and End View, Edison New Single Reduction Street Car Motor.

ture space are bored out at one boring, and by loosening two bolts the armature can be slipped out completely, so that inspection can be effected with great facility. The armature, which is of the Gramme type, is built up of punched soft iron rings insulated from each other, and with the end plates of wrought iron and bevelled. On the interior diameter of the hollow cylinder built up in this manner, there are four grooves placed 90° from each other, and into these grooves the aluminum-bronze spiders are pressed by hydraulic pressure, two spiders being employed and bolted together. In this way a firm mechanical connection is made between the armature shaft and the ring.

The diameter of the armature is 18 inches, and its length 13 inches. The shaft is 3 inches in diameter, and upon each end is mounted a pinion which meshes with the large gears at each end of the axle, thus equalizing the power on the axle. One end of the magnet forms the car axle bearing and the other is suspended by a spring at the nozzle for easy starting, The commutator has been made specially large, being 10 inches in diameter.

The armature is wound in 140 sections, and on account of the strong field employed, and the method of connection to the commutator, no spark is observed. The winding is put on in one continuous length of wire, and at each section a tap wire of German silver is taken to the commutator. The object of employing a German silver wire will become obvious when it is pointed out that, as is well known, the brush in passing from one commutator segment to another short-circuits the coil between them for an instant. The introduction of the German silver wire with its increased resistance reduces the current induced by the short circuit considerably, and, hence, the sparking due to that cause; and it also aids materially in cutting down the current, if by any accident the motor should be accidentally short circuited. It will be evident, however, that in the operation of the machine only those two German silver wires are in circuit which lead from the commutator segments immediately under the brushes, all the others being, of course, without current during the period between their travel from one brush to the other; hence, although the introduction of these two short lengths of German silver wire has no appreciable effect upon the normal operation of the armature it affords a simple method of avoiding sparking and danger from short circuits. The entire machine is encased in a water-tight cover, and its total weight with gears is 2,200 pounds. The machine is rated at 25 h.p., but will readily develop 30 h.p. It is intended to apply two of these machines to each car of the double truck type, while one machine alone will be ample to drive the smaller cars. The motor is of the series type and the regulation is effected by varying the combination of the fields, which are wound in three sections. By this method of regulation the use of a rheostat is avoided.

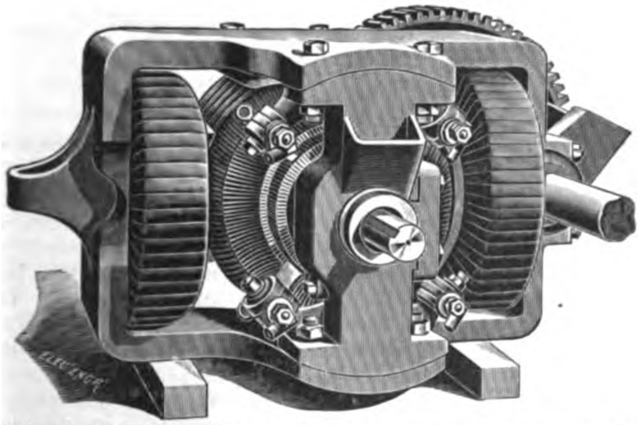


FIG. 3.—THE NEW EDISON SINGLE REDUCTION STREET CAR MOTOR.

The four carbon brushes employed are rigidly fastened to the frame and require no shifting throughout the range of load to which the motor is subjected. The motor is calculated to revolve at 460 revolutions with the car running at a speed of 12 miles an hour.

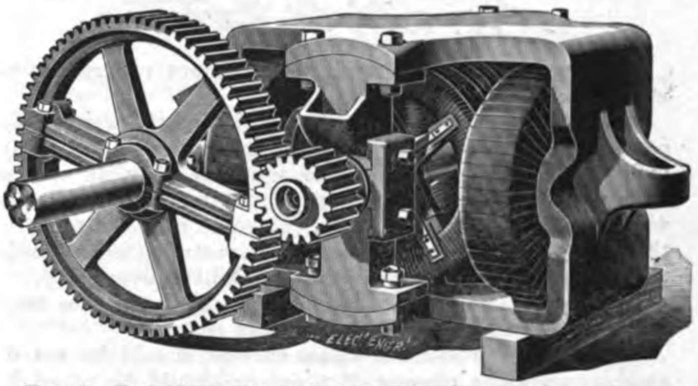


FIG. 4.—THE NEW EDISON SINGLE REDUCTION STREET CAR MOTOR.

It is also contemplated to construct immediately a 15 h.p., single reduction iron clad motor of the same type for lighter work.

THE WAVE-LENGTHS OF ELECTRICAL OSCILLATIONS.

In repeating the classical experiments of Hertz upon the wave-lengths of electrical oscillations, H. K. Waitz, has arrived at the following conclusions, namely:—(*a*) A discharge of an induction coil of a definite species excites oscillation of different wave-length, which may extend over an interval of many octaves. (*b*) Amongst these electrical oscillations there is one of greater intensity, the wave-length of which is determined by the dimensions of the conductors. (*c*) The electrical oscillations in or upon conductors change their wave-lengths when the medium surrounding the conductor changes.

THE THEATROPHONE.

THERE was founded last year at Paris, the "Theatrophone Company," the object of which is the institution of a telephonic theatrical service. The company has erected in the various public places, such as cafés, clubs, restaurants, etc., a certain number of automatic telephone receivers by which, on introducing a fifty centimes piece, one is placed in communication, for five minutes, with theatres or concerts indicated on the apparatus. At present the Opera Comique, the Bouffes, and the Nouveautés are the only theatres in connection with the system, but the number will be soon increased. The Theatrophone Company intends to supplement this public service by a private service, available for all subscribers to the State telephone system. By means of the monthly subscriptions of fifteen francs, and a payment of fifteen francs per evening for this service, a subscriber to the Paris system can enjoy telephonic communication with a given theatre, selected from among those connected with the service, during the entire performance, and for any number of listeners. The prices given above are for two receivers. The addition of extra telephones, so that several persons may hear at once, entails a further charge of two francs per pair per month.

THEATRICAL ELECTRICIANS.

Since the introduction of electric lighting into nearly all the theatres of the country, it has been found necessary to add an electrician to the corps of assistants. He is not necessarily an expert in the scientific sense, but he must know how to repair any sudden breaks or interruptions, and be able to control the lights sufficiently to answer the purposes of the play. The electrician traveling with the "Poor Jonathan" company gets $20 a week.

CENTRAL STATION MANAGEMENT AND FINANCE.—II.

BY

Horatio A. Foster

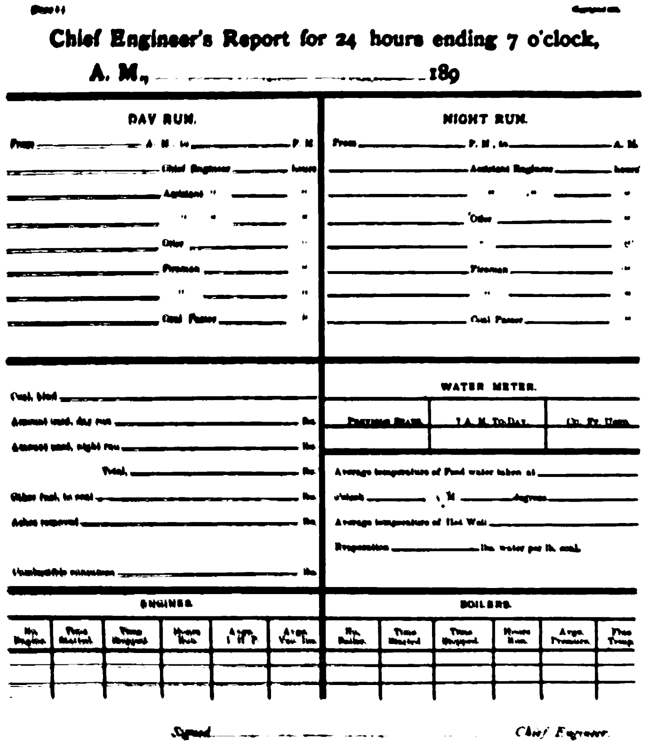
We next take up the regular department reports, commencing with the boiler room.

This sub-department is, in the opinion of the writer, one of the most important of all, as great waste is so easily made if firemen are careless or ignorant. By all means have the best fireman that money can hire, as he is the man who shovels away your dollars. The data required to show the condition and efficiency of this department is so simple that it is folly not to have the items at hand every day.

Each boiler should have its number which must be used in all references to it for conditions or repairs.

The average pressure of steam carried, should be noted, and any irregular change of pressure should be noted in remarks.

Some engineers keep a regular log, recording the pressure of steam, etc., every half hour or hour; this is not deemed necessary by the writer, as all modern steam plants are provided with a good damper regulator which will easily keep steam pressure even throughout a run. A good recording gauge is a very handy instrument for use in the larger stations, and is always a good check on the motive power department.



Chief Engineer's Report for 24 hours ending 7 o'clock,

A. M., ____________ 189

DAY RUN.

From ______ A. M. to ______ P. M.
______ Chief Engineer ______ hours
______ Assistant " ______ "
______ " " ______ "
______ Other ______ "
______ Fireman ______ "
______ " ______ "
______ Coal Passer ______ "

NIGHT RUN.

From ______ P. M. to ______ A. M.
______ Assistant Engineer ______ hours
______ " " ______ "
______ Other ______ "
______ " ______ "
______ Fireman ______ "
______ " ______ "
______ Coal Passer ______ "

Coal, kind ______
Amount used, day run ______ lbs.
Amount used, night run ______ lbs.
Total, ______ lbs.
Other fuel, in coal ______ lbs.
Ashes removed ______ lbs.
Combustible consumed ______ lbs.

WATER METER.

Previous Read.	7 A. M. To-Day.	Cu. Ft. Used.

Average temperature of Feed water taken at ______
o'clock ______ M ______ degrees ______
Average temperature of Hot Well ______
Evaporation ______ lbs. water per lb. coal.

ENGINES.

No. Engine.	Time Started.	Time Stopped.	Hours Run.	Avge. I. H. P.	Avge. Vac. Ins.

BOILERS.

No. Boiler.	Time Started.	Time Stopped.	Hours Run.	Avge. Pressure.	Flue Temp.

Signed ______ Chief Engineer.

BLANK NO. 2.—CHIEF ENGINEER'S REPORT.

The amount and kind of fuel fired should be noted, stating in the remarks column any particulars as to quality, that are expected to be noted by officers in charge. Where part wood is used, and it is desired to reduce it to coal equivalent, it is only necessary to multiply its weight by .4, which gives the equivalent in lbs. of coal. The weight of ashes and clinkers removed should always be recorded, as the percentage of waste in fuel indicates the quality.

The amount and temperature of feed water is also very important. The first, when compared with the amount of fuel consumed, gauges the evaporative efficiency of the boilers. The only convenient way of recording this is by some good meter. The dial reads in cubic feet, which is reduced to pounds by multiplying by 62½.

It is necessary to know the temperature in order to reduce the evaporation to a standard, as, say, from and at 212°. A handy and cheap way to take it is to have a ⊥ inserted in the run of the feed pipe, close to the boiler. A plug with a ⅜ inch brass tube with its bottom end plugged is screwed into the side opening. This tube is filled with cylinder oil to hold the heat, and the temperature can be taken at any time by putting a small thermometer into the oil.

The names and time of all employés are all that are necessary to give the expense, supplies being given by the storekeeper and only placed on the weekly or monthly report. Blank No. 2, report of chief engineer, has space for all the data mentioned above. The same blank also has space for the necessary data for the engine room. This data includes the numbers of engines run, with the time of starting and stopping them, and, where possible, the average indicated horse-power. Where engines are used on the same machines—and changes are seldom made—if half hourly cards are taken for a few nights running, and the average load is figured for them, then cards taken on the same engine at the hour which was found to agree nearest with that average load will be approximately correct. This will be more so if taken on or about the 21st of March or September, which is the average time for the year.

Where condensing or compound engines are used, it is well to record the average vacuums. If vacuum varies much, the fact should be noted in "remarks" and the air pump and condenser should be overhauled.

In the space left for remarks should be entered full details of all work done out of the usual routine, such as washing out boilers, repairs on fire boxes, engines, pumps or other work.

A good chief engineer will find plenty to do to keep the motive power department up to the best conditions of efficiency. As a general thing, more trouble and waste takes place in this department than in the electrical, and largely from the fact that few station managers understand the advantages of employing a good chief engineer.

OHMTOWN AND VOLTVILLE—"A TALE OF TWO CITIES."

BY

G. T. Evans.

Ohmtown and Voltville, according to the last census, are almost equal in population—but the similarity goes no further. Ohmtown is surrounded by a fence of fogyism and penny wisdom—Voltville lives in an atmosphere of shrewd enterprise. Ohmtown reaches out her hand for improvement with as much trepidation as the little boy does for the school strap, she is uncertain about the amount she wants and comes away with a meagre fistful and a sense of offended economy. But Voltville—and she believes in economy, too—though not in the kind which paves a street twice in three years at $1,000 a job when a $1,500 job will last ten years—has an eye elected by public opinion to keep a watch for what may improve the town. If such an object is seen, and after mature deliberation is deemed necessary, all the energy of the people is concentrated to get the best of the kind at the cheapest price. In fact, the paradox "Best and Cheapest" is the aphorism of the town.

A few years ago the electric fever struck each of these places. Voltville had it heart, mind and body, but Ohmtown had a slight superficial attack. The rich Mr. Impedance was elected president of her company. He and the directors possessed the characteristics of the town to an exaggerated degree, so the quality of the new electric plant was an easy thing to foresee. Arc lights were to be used for the streets, and for the sake of economy it was decided to have them about three times further apart than is the ordinary practice. Thus the arc capacity was estimated. Then for the incandescent system a local investigator was sent out to discover how many lights would be taken. Tom Brown, the baker, said he would not have the dangerous stuff in his shop. Mr. Reluctance, the dry goods merchant, thought probably he would not, and so, the investigator, obeying the teachings of the town, left off from his list the names of Messrs. Brown and Reluctance together with some hundred of their brethren, and made his report to call for about half the number of lights an experienced solicitor would have estimated on and secured contracts for. Thus was the incandescent capacity calculated. And knowing so exactly the amount of power required, the contract was let for a station building just large enough to hold the machinery. No extra room was wanted; Ohmtown abhorred a space. The electrical public were soon informed of the intentions of Ohmtown, and the kind of work that was required. Bids were sent in accordingly. The Rush and Shiftless Construction Co., though closely pushed by the Cheapest, finally secured the job, being able to beat the latter by furnishing a quantity of wire that had already served a term of years elsewhere. And Ohmtown was delighted with her bargain—overjoyed when the second-hand boiler came; and she expatiated on the strength of its numerous patches. And the engine was a beauty though it had run a sawmill for a generation. But great is paint! In the infancy of dynamo building, the second-hand dynamos that Ohmtown bought would have been considered wonderful. Ohmtown thought they were now, but Ohmtown didn't know much about efficiency. Yet, with all the self-satisfaction of Ohmtown, no one praised the pole line. Before its arrival Ohmtown was not an extremely bad-looking city, but after—well, poles that "belly" to every point of the compass and look as if some gigantic Indian had used them for bows are not conducive to beauty.

Voltville had, of course, proceeded on entirely different lines. Ohmtown would have lifted up her hands in horror and hung the flag of Economy Hall at half-mast if she had seen the first act of Voltville. An electrical expert was sent for. Now electrical experts don't work for fifty cents per day, but they earn what they get, and Voltville found that out as time went on. Mr. Accuracy, E. E., made a long study of Voltville; its shape, size, peculiarities and tone of its people. Then he made public his plans. He stated what system would best suit Voltville, how many lights should be arranged for—in short, he gave points on all the main details, and reasons for each. His plan was an expensive one to carry out, but was in conformity with Voltville's motto. The Rush and Shiftless Co. didn't get this contract. Its bid was below that of the Stability Co. but the Stability got the job. The reputation of the Rush and Shiftless concern had not been helped by work of the Ohmtown pattern.

Voltville had reason to be proud of her new industry; the station building was large and had plenty of spare room. The boilers, engines and heaters were modern and built to save coal—the steam pipes were covered for the same reason. The electrical machinery was the best to be had from a responsible manufacturer. A traveling chain tackle was in place to save valuable time, and it was saved too. Armatures didn't burn out often, but when they did there was no running about after a rope and pulleys and half a dozen men. This was Ohmtown's plan. Voltville had a very respectable looking pole line. In the central part of the town iron poles were used, and the wooden poles were straight, were stepped and painted, and their butts treated with waterproof compound. They were intended to last. First-class wire was used throughout. Voltville couldn't afford to buy coal to supply leaking circuits.

Ohmtown's lights, when the station was started, were very good considering the motion of the saw mill engine, but there were obviously not enough. Tom Brown and Mr. Reluctance and their doubting friends found now that they wanted lights and sent in applications. More arc lights were necessary. The station was already worked to its capacity. Sheds were added—more second-hand machinery of various types was bought, and the coal melted and melted. Inefficient machinery has a great appetite for coal. Voltville is to-day paying dividends on her electric investment. Owing to Mr. Accuracy's forethought, there is still room in the station. A power circuit for stationary motors is worked, and preparations are being made to supply current for an electric railroad. The superintendent is a follower of Mr. Accuracy. He is competent, and Voltville is sensible and pays him a living salary.

Ohmtown *may* pay a dividend sometime. Her station now resembles a village of additions. The stockholders' pockets are being picked for repairs on the apparatus. The wisdom of the directors endeavors to help matters by cutting down help and wages. The superintendent (?) is a man of all work. He is expected to string wires, climb poles, dig holes and shovel ashes, for $1.50 per day. He is a willing, anxious fellow, but he succeeds no more in doing his various duties than the distressed hen struggling to cover 15 or 20 half-grown chicks with her wings.

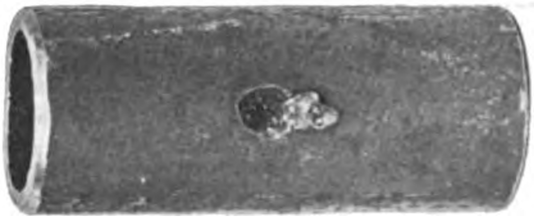
Is local electric lighting a failure? Ohmtown answers a dismal "Yes." Voltville points to her swelling pocketbook.

AN INSTANCE OF CARELESS WIRING.

BY

C. J. H. Woodbury.

The accompanying engraving, reproduced from a photograph, represents a piece of an automatic sprinkler pipe in a mill, with which an electric wire on a circuit used for incandescent lighting was in contact, and against which it chafed by the jar of the mill until the insulation was abraded. The circuit was grounded, and the diversion of electricity was sufficient to fuse a small amount of the iron, which cooled at the side of the depression. The pipe was perforated with an orifice about one-sixteenth of an inch in diameter, out of which the water in the sprinkler system issued, and this first called attention to the accident. This is only one of many incidents showing the great importance of maintaining an actual separation between electric lighting apparatus and iron piping.



THE RESULT OF CARELESS WIRING.

TACOMA, WASH.—The officers of the Commercial Electric light and Power Company, recently elected, are as follows: President, George Browne; vice-president, M. G. Denton; treasurer, Chester Thorne; secretary, Robert Sale Hill; directors, C. W. Griggs, D. P. Newton, George Browne, M. G. Denton and Chester Thorne.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XI. NEW YORK, APRIL 29, 1891. No. 156.

Every material operation and every invention is founded on some law of nature, and the more intimately the operator is acquainted with the principles of his art, the more fitted he is to improve it.—Joseph Henry.

A NEW DEPARTURE IN CENTRAL STATION ENGINEERING.

A SUCCESSFUL central station manager once remarked that the commercial success or failure of an electric central station depended upon the management of the coal pile. It is obvious that for economical operation the central station must be arranged in the light of the most modern practice, not only in electrical but in steam engineering. It may be looked upon as a well established fact that the best results are obtained in central station practice by the employment of units of power both in generator and dynamo, these units, of course, to be adapted to each special case, and depending upon the amount of current distributed from one centre. The size of the unit once being determined, the next question is the manner in which these units shall be operated. Although a great deal of discussion has been carried on as to the relative superiority of high and low speed engines, there can be no question as to the great advantage, in many respects, of direct connection between engine and dynamo, and if to this be added a construction of dynamo such as will be adapted to an engine of known high economy, the best practice in the light of present knowledge will have been attained. The recent improvements which have been made in steam engineering, especially in the triple expansion engine, render this type eminently fitted to central station practice, and when directly connected to a dynamo specially adapted for the speed which can be attained from such engine, the economy must of necessity be high. Taking this view of the case, evidently, the Edison Company have undertaken the most decided departure in practice in this country, and our description on another page of the new vertical triple expansion engines they are building, and their new direct connected generators, will be read with interest, especially by central station managers. The experience which has been gained abroad in the employment of this type of combined engine and dynamo is such as to fully warrant its continued application, and it is not too much to say, we believe, that the large central station of the future is destined to be run upon the new methods now indicated.

It is evident that a further stage of development is now reached in large central station work, and that the production of current by these large generators puts electric lighting at once on a parity with gas. With the cost of the two illuminants the same to the consumer, there is no question as to which light he will choose.

URBAN POPULATION AND ELECTRICITY.

A VERY interesting bulletin just issued by the Census Office gives the growth of urban population in the United States. It shows that if there be included in the urban population all communities down to a limit of 4,000, that population reaches 18,235,670, out of a total of 62,622,250 or 29.12 per cent., or an increase of nearly 7 per cent. over 1880. The same fact is even more strikingly brought out in the statistics of cities over 8,000. Of such cities there were 286 in 1880; to-day 443 are to be found, or an increase of 50 per cent.

The decade that has witnessed this amazing growth—a growth that Mr. Porter is gravely accused of understating—has seen also the rapid introduction of the electric light, and to-day there are very few towns even down to the 4,000 limit that are not familiar with the cheering beams of the silvery arc. A large proportion also of the cities of 8,000 population enjoy the rays of the golden incandescent, but it is evidently here that a great deal of work remains to be done, in so far as the extension of electric lighting is to maintain its higher rate of increase as compared with the rate of urban centres.

When we turn to the department of electric railways, the field reveals itself as still one of large opportunity. In other words, we can still haul in a good deal of slack before settling down to a normal rate. The electric light is an old story to-day in many a town that has never had even a horse car, but which now is anxious to catch up by the immediate adoption of electric cars. But it might be said, as was said recently by an electric engineer, that this work of exploitation would reach its end in three years at the rapid pace now being made. There is, however, an abundance of work beyond, not only within the cities but outside them and in the new towns; and we expect that the census returns of the year 1900 will exhibit the effects of electricity in its application to the "commuter" service around all the large cities. It would be hardly going too far to say that in a few years every traveled road will be made a railroad by the presence of an electric track along it.

Another interesting, but less complete, return, published by Superintendent Porter last week, dealt with the relative economy of cable, electric, and animal motive power for street railways, covering statistics of fifty lines, ten operated by cable, ten by electricity, and thirty by animal power. The figures show : Total cost of cable roads, including equipment, $26,351,416 ; passengers carried, 101,995,695, at a cost of $3,286,461 ; operating expenses per car mile, 14.12 cents ; per passenger, 3.22 cents ; length of tracks, including sidings, 143 miles. Total cost of electric roads, $2,426,285 ; passengers carried, 8,031,214, at a cost of $326,961, or 13.21 cents per car mile and 3.82 per passenger ; total track mileage, 67.22. Total cost of animal power roads, $22,788,277 ; operating expenses, $6,986,019 ; passengers carried, 190,434,783 ; expense per car mile, 18.16 cents, and per passenger, 3.67 cents ; miles of track, 552. Nine of the electric roads quoted were operated by the trolley system and one by the storage-battery system. Even on this limited basis the comparison is favorable to electricity, and it becomes more and more so as the new roads with improved mechanism go into operation. While Mr. Porter was digesting these figures, the electric roads were increasing in the single year 1890 from 160 to 281, although street car companies increased only 5 per cent., and not one of those roads had by any means reached its point of highest economy and efficiency. One could hardly expect immediate perfection in so new an industry.

THE VALUE OF "GUARD WIRES."

In a recent issue we took occasion to comment on the situation at Albany, N. Y., where the troubles at the telephone exchange have been attributed to the absence of guard wires. Mr. W. H. Cull, of the electric railway in that city, stated through our columns his belief that guard wires were not always an unmitigated blessing, but were sometimes a danger in disguise. We are now able to give some more definite data on the subject. Mr. C. C. Upham, of the Salt Lake City roads, furnishes this week a summary of the replies received to a circular of inquiry on the point in question. His article shows that the value of the guard wires as a means of protection to the public has not yet been fully established. The fact is the guard wires are not much stronger than the fragile telegraph and telephone wires with which the trouble begins. Some day, perhaps, somebody may invent an electric railway conductor with a pent roof that will shed safely all the rusty and rotten wires that fall upon it, but until then, it does seem only reasonable to try to protect with fuses, electrical apparatus liable to be smitten. Even if there were no railway circuits, this precaution would still be eminently proper.

THE EDISON SINGLE REDUCTION STREET CAR MOTOR.

The description which we give in this issue of the new Edison single reduction street car gear, while interesting in itself as showing the change which is rapidly going on in the methods of electric railway operation, also serves to draw attention to the changes which have been gradually made in the methods of construction, and the materials employed in street railway motors. Thus it will be noted that the Gramme armature is now finding employment where formerly the Siemens ring was almost exclusively used. The simplicity of the Gramme ring, the thorough independence of each coil from its neighbor and the ready manner in which it can be repaired, together with its adaptability for slow speed work, make it probably the form best adapted to this purpose. Another important feature is the employment of soft cast steel for the magnetic frame of the machine. Experience has show that the permeability of this material is little, if any, less than the best wrought iron, and the readiness with which it can be fashioned into the required shape by casting must at once stamp it as a most valuable addition to the working materials of the electrical engineer.

CURRENT CONSUMED BY ELECTRIC MOTORS.

The manufacturer of motors, not less than the user, is always interested in the quantity of current consumed in motors, as upon this point the efficiency, and hence the cost of electric power depends to a large extent. The table we give in another column, prepared by Messrs. Crocker and Wheeler, will therefore find a useful place wherever electric power is applied. It will be noted that the table has been calculated on a very reasonable basis, the motors of the smaller powers, especially, being taken at an efficiency which certainly brings any calculations based upon the tables within conservative limits. For the same reason the arc motors are taken at a somewhat lower efficiency than those designed for constant potential circuits. Dr. Wheeler also points out an interesting fact which is generally overlooked. He shows the advisability of careful consideration in the selection of the size of motor, which should be taken rather above the estimated power than below it, since the motors of larger size have a higher average efficiency than those of less power. . Besides this, however, it is always advisable to have a certain amount of power in reserve which can be called upon in an emergency without endangering the life of the motor.

Electric Railroading in California.

As our Electric Railway Notes show, there is considerable activity in electric railroading in California ; in fact, it might fairly be called a "boom." This pleasing condition of things is due to a change in the law, as until recently the use of electricity as a motive power for street cars has not been legal. Mr. J. W. Hartzell, manager of the San Francisco & San Mateo Railway Co., to whom we are indebted for a copy of the bill, expresses his belief that there will be a great many new roads in the near future. This is, as he says, an important item of news for Eastern people interested in electrical apparatus and supplies. We are glad to note the new opening for engineering and trade. It is not unlikely that local electrical manufacturers in the State may also be stimulated and benefited by these favorable circumstances.

THE USE OF "GUARD WIRES" ON ELECTRIC RAILWAYS.

BY

Chas. H. Clapham

Some time since, the telephone people of Salt Lake City petitioned the City Council, praying that the street railway companies be required to put up guard rails over the trolley wires. The matter was referred to the committee on streets, and has not yet been acted upon.

The Salt Lake City Railway Company and the Salt Lake Rapid Transit Company sent out circulars of inquiry on the subject to some 40 electric railway companies in the country. These circulars brought answers from 28 companies, who reported all sorts of experiences. These experiences indicate that the greatest amount of doubt exists as to the value of guard wires.

There seem to be out of 28 companies answering, 18 that use guard wires and 10 that do not use them now; 13 put them up voluntarily, and seven at the direction of municipal authorities. Seventeen put the wires up at their sole expense, while two divided cost with telephone companies. Four companies put up the guard wires to protect the public, eight to protect the overhead wires, four to protect all interests, and three in self protection. Twenty-two companies used span wire construction, three centre pole and three both methods.

Nine companies state positively that the guard wires have answered the purpose; six answer as decidedly that they have not, while five are doubtful. Sixteen companies still have the wires up, while three have taken them down. Out of the 28 companies, nine recommend the use of guard wires; seven do not recommend their use; two recommend them in some places, that is, at street intersections; two are doubtful, and eight have had no experience with them.

An official of one of the metropolitan companies, in fact, one of the largest companies in the country, writes: "In my opinion the guard wires are an additional source of danger, both as regards fire and the public, and it would be far better if additional precautions were taken with the other wires, such as providing them with fuses where they enter buildings so that in case of contact there would be no danger of fire, and thus doing away with guard wires entirely. I find this opinion held also by many other electric railway men." An official in one of our large western cities writes: "Three days since, a broken guard wire carried the current so as to strike a passing team, killing both horses." Another writes, "Almost all electrical disturbances have been caused by guard wires coming in contact with other wires."

Another company do not recommend the use of guard wires but put them up "because they are recommended by the electrical company whose system we are using." A southern railway official says: "All guard wires have been taken down because they were constantly breaking and causing trouble in the street. There has been practically no complaint since removed." Another company still has the wires up but does not recommend their use, because "when any wires are down they increase the trouble and never stay where placed." An Eastern superintendent has taken down his guard wires, "because of no special benefit."

It would seem from all this testimony that the use of guard wires is not an unalloyed blessing.

UNFORTUNATE ILLNESS OF A DISTINGUISHED FOREIGNER.

The *New Haven Journal* says gravely that during a test of an electric car in that city recently, the "Rheo Stadt" gave out! The cause of this gentleman's collapse is not positively known, but it is supposed to be due to current jam.

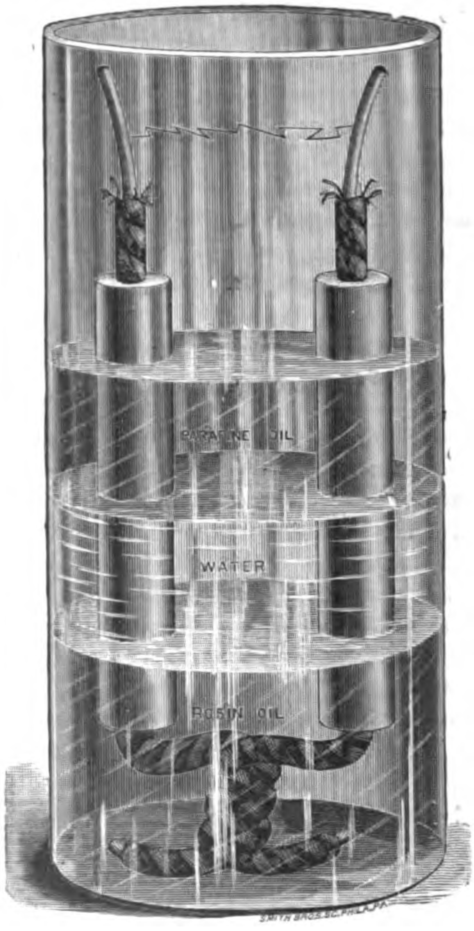
OIL AS AN INSULATOR FOR HIGH POTENTIALS.—I.

BY

David Brooks

There is much more written about the uses of oil for electrical purposes now than ten years ago and not referred to, as then, as "oleaginous nonsense." Following up the note of mine in the preceding number of your journal, I immersed a small induction coil called "Shocking Machine" in oil and increased the inductive effects to such an extent that, with the plunger withdrawn, no one could bear the shock. I took it to two makers of those instruments and neither of them cared to make use of the improvement because, by the use of the plunger, sufficient effect could be produced that any person desired to bear.

The effect was greatly increased when I discovered the properties of rosin oil. Although I had tested rosin oil earlier, I could not make near as much out of it as of paraffine oil, for the reason that ordinary rosin oil has about the same specific gravity as water and held water in suspension. But when you come to heat rosin oil and drive out the moisture its insulating properties are immensely increased and the distillers are able to make an oil that is far heavier than water or even heavier than sulphuric acid or any other liquid that I have ever experimented with, unless it be quicksilver.



An Experiment With Oil Insulators.

The accompanying illustration, shows an experiment that was exhibited at the Electrical Exhibition in Philadelphia, in 1884, nearly seven years since. It was labelled "THE ELECTRICAL POUSSE CAFÉ." It will be observed that when the wires are disconnected, a cover can be placed over the jar to keep out the dust. I have that jar to this day, and have never been able to spark through the covering of the wires where they are twisted together, as shown, in the oil. The glass tubes prevent the spark from going through the water.

Now, I beg the reader to consider what advantage there is in having an insulation that is heavier than water and is not penetrated by it, or does not absorb it. How many hundreds of thousands of dollars' worth of gutta percha or India rubber insulated conductors have failed within the past ten years on account of the access of moisture to the conductor? Not immediately, but in time, the insulation disintegrates and decays, becomes spongy, or contains fissures. The first oil-insulated cable that was laid for practical use on my system was in London, in 1880, eleven years since. I then used paraffine oil and they had trouble in keeping it in the pipes. As soon as I found out the virtues of rosin oil I sent them a number of barrels of it and since that was introduced they have had no trouble.

The London *Electrical Review* recently contained a series of articles entitled "Storms and Telegrams," by Messrs. Slingo and Brooker. They state as one of the advantages of the oil system that if the insulation is punctured by atmospheric electricity the oil soon closes up again the puncture, and that, to use their words, "it is self-sealing"; bringing that feature into consideration, in connection with the fact that the oil is heavier than water, it is worthy of note that, since the introduction of the rosin oil, of the many thousands miles of conductors that have been laid, for telephone, telegraph and electric lighting purposes, not a single interruption has occurred to my knowledge.

I had forgotten entirely that I had obtained a patent for the use of oil in induction coils until I read the article on "Experiments on the Transmission of Power at Very High Potentials,"[1] and I do not know that I can say much more in its favor than is stated by Mr. C. E. L. Brown and by Prof. Thomson.

Not two weeks since, I was experimenting in the laboratory of Mr. Carl Hering with the Holtz machine. We twisted two No. 18 wires covered with paper to a thickness of a No. 8 gauge. There was a great deal of brush leakage between the two wires above the oil, so we placed a glass tube over each to cover the wires close up to the poles of the machine. To keep the glass tubes in position we laid a wire across the top of the jar and then went on sparking between the two spheres until we had them separated 4¼ inches. Separating them a little farther the spark went through both glass tubes to the wire on the top of the jar supporting them in position. Warren de la Rue and Hugo W. Müller give the electromotive force of a 4 inch spark between a point and a disc as 93,500 volts; but this 4¼ inch spark was between the two spheres, which is much harder to accomplish than between a point and a disc.

THE USE OF THE GOOCH CRUCIBLE AS A SILVER VOLTAMETER.

In order to avoid loss of silver by the washing of the deposit in a voltameter, M. Lœb recommends the use of a modification of the well-known Gooch crucible:—A rather tall and narrow platinum crucible having a perforated bottom is fitted into a glass cup terminating in a syphon. The two are united by means of a piece of India-rubber tubing which should be freed from sulphur, although there is no real danger of contact with the silver solution. The apparatus is filled with silver nitrate solution, so that the top of the syphon is not quite reached and is then set upon the stand. The crucible rests in a well-fitting brass block to which the negative wire is attached. The anode consists of a silver cone suspended within the crucible by means of a silver wire attached to a horizontal bar insulated from the cast-iron base. When the electrolysis is complete, the residual nitrate of silver can be entirely removed without in any way disturbing the deposit by simply filling up the crucible with hot water several times. The crucible is then detached from the syphon, dried and weighed.

RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.

BY

Clayton W. Pike.

IN THE ELECTRICAL ENGINEER of April 1, Mr. Carl Hering gives a diagram for the wiring of incandescent lamps so that all the lamps upon a pair of mains shall have an equal potential difference at their terminals.

If an arrangement, such as that shown in Fig. 1, were employed, the lamp *a* would have the same potentials at its terminals as any other lamp *b*, for the current for *a* passes over that portion of the mains whose length is $A^1 B^1$, while the current for *b* passes through the length B A, and since A B = $A^1 B^1$ and the current through *a* and *b* is the same in amount, the loss of potential on the mains for each would be the same, and therefore, the potential difference at the terminals of *a* and *b* equal. From this one might jump at the conclusion that any other lamp *c* would have the same potential. Commercially this conclusion is sufficiently true, and this was, without doubt, the sense in which Mr. Hering meant to use it. Indeed, until Mr. Loomis' criticism upon it in your issue of April 15, I have neither seen nor heard any dispute as to its being theoretically exact. Mr. Loomis points out that this is not the case and that the lamp *c* will have a less potential difference than *a* and *b*. It has seemed to me worth while to discuss the matter more in detail than he has done.

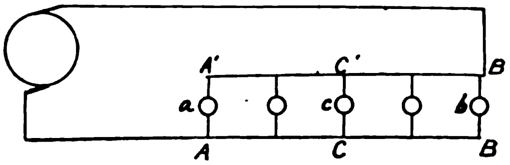


FIG. 1.

First, consider the arrangement shown in Fig. 2. Suppose the potential between A and B^1, which I will call $V_{A B^1}$ to be 100 volts, and that each lamp requires one ampere. Also that the resistance from A^1 to C^1 equals that from C^1 to B^1, A to C, or C to B, and each has the value 1 ohm. In the figure the number of amperes flowing through these parts of the mains are indicated. Now the drop in potential from B^1 to C^1 equals $2 \times 1 = 2$ volts. The drop from C^1 to $A^1 = 1 \times 1 = 1$ volt. Therefore the drop from B^1 to A^1 is 3 volts, and the potential difference between A and $A^1 = V_{A A^1} = 97$ volts. Similarly $V_{B B^1} = 100 - (2 + 1) = 97$ volts. That is, if we place a 97 volt lamp between A and A^1, and another at B B^1 they will burn with equal brilliancy. Let us now find the potential difference between C and C^1. The loss from B^1 to C^1 is $2 \times 1 = 2$ volts, and the loss from C to A $= 2$ volts. Therefore, the total drop is 4 volts and the potential difference $V_{C C^1} = 96$, which is one volt less than that at A A^1 or B B^1. For

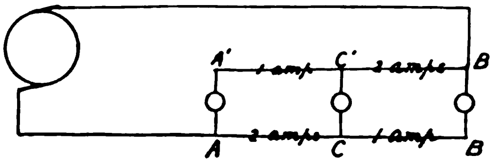


FIG. 2.

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[1] See THE ELECTRICAL ENGINEER, April 8, 1891.

points intermediate between A and C we should get values of potential between 96 and 97 volts. This shows very clearly that the potential is not the same for all the lamps, and is least for the middle one.

Consider the matter from another point of view. Suppose that, as above, A and B^1 differ in potential by 100 volts. How shall we wire the three similar lamps so that they may have the same potential? Fig. 3 shows how this may be done. All portions of the mains are of the same guage of wire, and, since the same current flows in each, the drop of potential for equal lengths on A^1 B^1 and C^1 B^1 will be the same. This is also the case with the wires A C and A B.

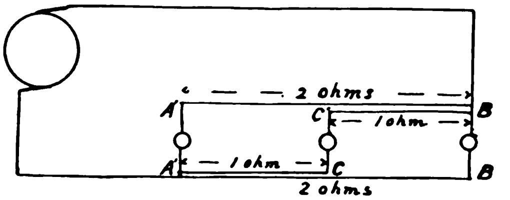

FIG. 8.

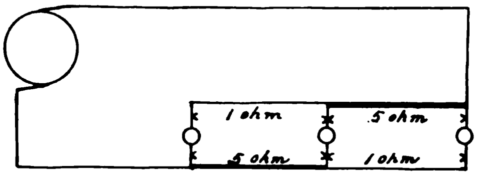

FIG. 4,

Therefore the wire B^1 C^1 may be laid alongside A^1 B^1 and in contact with it, and likwise A C put in contact with A B without in any way disturbing the flow of currents or the equality of potentials for the different lamps. The arrangement will then be as in Fig. 4.

We now see why the arrangement of Fig. 2 did not give the desired equality of potential. Computation similar to that given for Fig. 2 will show that the potential for all the lamps is the same, and has the value 98 volts, if V A B^1 is as before, 100 volts.

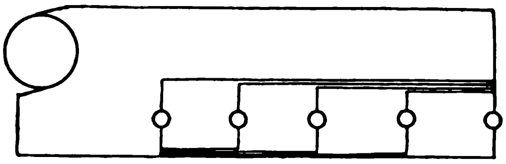

FIG. 5.

It will, of course, be noted that the resistance on the mains between the lamps is many times what would occur in practice, and that as this resistance diminishes, so does the variation in potential between the middle and end lamps. Practically the arrangement in Fig. 2 gives us equality of potentials among the lamps on that pair of mains. So far we must agree with Mr. Loomis, but when he says that "a little study will convince us that no system can be devised to produce the result (equality of potential among the lamps on a given pair of mains) in the sense of being theoretically perfect" I am inclined to think he has gone a little too far. Suppose we apply the principle of Figs. 3 and 6 to a considerable number of lamps giving the arrangement in Figs. 5 and 6. In Fig. 5 the wires are all of the same cross section and are calculated to give the desired loss when the current for one lamp is flowing through each. Suppose that each wire has a section of 1,000 circular mils. Fig. 6 shows the appearance when the separate wires have been pushed into electrical contact. The bundle of wires may then be replaced by solid wire which changes its area of cross section by 1,000 circular mils as it passes each lamp. Such an arrangement, though obviously impracticable, is yet, it seems to me, theoretically perfect in the attainment of the desired result.

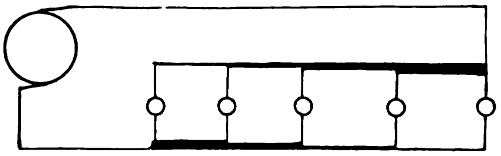

FIG. 6.

ELECTRICITY IN THE PRODUCTION OF ALUMINUM.[1]

BY ALEXANDER S. BROWN.

OF all the metals commercially familiar to us, aluminum has unquestionably made the most rapid progress. The long and tedious development of iron, steel, copper, tin, lead, zinc, etc., extending over centuries and centuries, is familiar to us all; the fact that this new metal (only discovered in 1827, and extracted in perceptible quantities not earlier than 1854) has already entered into commercial competition with the oldest and most useful metals, substantially at their own prices, would alone make aluminum a most interesting subject of study and speculation.

The author then traced the history of the metal beginning with the year 1760, or thereabouts, when a chemist named Morveau, by calcining alum obtained a substance which he called alumina. Shortly thereafter Lavoisier suggested the existence of metallic basis in the earths and alkalies, and, naturally, alumina was immediately suspected of being a metallic oxide.

As early as 1807, Davy and others tried ineffectually to decompose alumina by various means, including the use of the electric current. A chemist named Oerstedt thought he had produced the metal in 1824, but a German chemist named Wöhler was the first to actually demonstrate its existence. He extracted the metal in 1827 by decomposing the chloride of aluminum by means of metallic potassium; 20 years later he also reduced it with metallic sodium. The first commercial product was exhibited in 1854 by H. St. Claire Deville, a French chemist, whose researches as to its chemical and physical properties (fully reported in the French journals of the day), were so thoroughly exhaustive that his writings are still standard authority on the subject. He used several methods, the most successful of which was reduction by sodium. Up to 1886 the annual production of this metal was less than 10,000 lbs., of which 6,000 to 8,000 lbs. were produced in France. In 1860 it sold at over $90 per lb. In 1887 it was sold at $5 per lb. and is now selling at $1 for a commercially pure article—this term signifying about 95 per cent. purity in the metal. It is known that by processes now in operation, the metal can be produced in large quantities at a price which will put it on a par with copper, bulk for bulk.

As early as 1856, one Mons. Alfred Monier, of Camden, N. J., claimed to have successfuly made sodium by a continuous process, as a preliminary step in the manufacture of aluminum, and, later, he exhibited several small specimens at the Franklin Institute. This is undoubtedly the earliest record of the production of aluminum in this country. Three years later, in 1859, the first aluminum works in England were started at Battersea, near Londondon, but no details concerning them are obtainable. In 1860 other works were successfully established at Newcastle-on Tyne, by Bell Bros., which were operated with more or less success until 1874. Mr. James Webster, in 1882, re-established the aluminum industry in England, forming the Aluminum Crown Metal Company at Hollywood, near Birmingham. The principal features of his patent, which this company operated, were the large cheapening of the manufacture of alumina Al_2O_3. He claimed to obtain a product containing about eighty-four per cent. of alumina—a substantial gain upon other known processes—and also to save half the cost of manufacture by utilizing by-products.

About 1886, a young Philadelphian—Mr. H. Y. Castner—invented and secured a number of patents to cover an improved and economical method of making sodium, which he claimed reduced its cost to twenty-five cents per pound. This invention he took abroad, and in 1887 the Aluminum Crown Metal Company, was re-organized under the name of the Aluminum Company,

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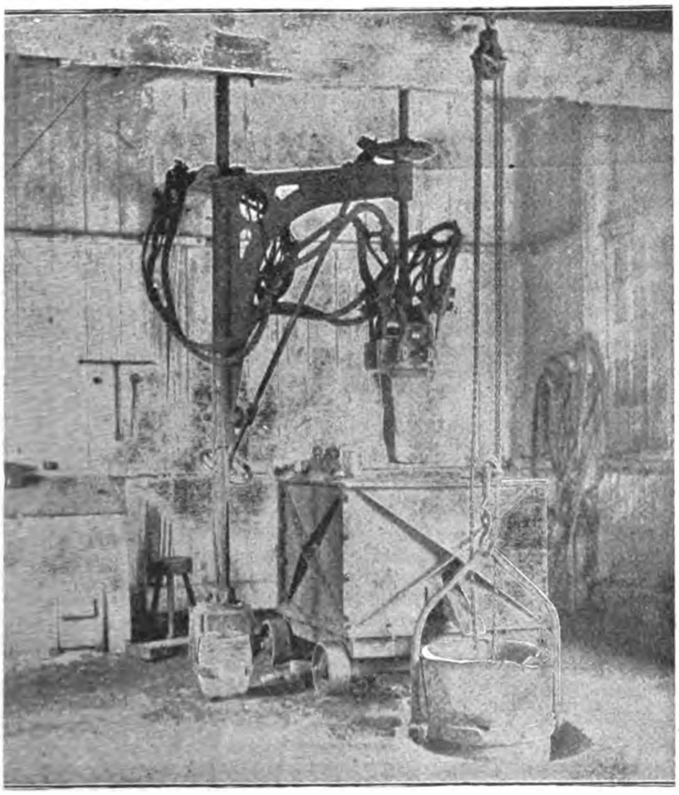
[1] Abstract of a paper read before the American Institute of Electrical Engineers, April 21st, 1891.

Limited, and extensive works for the manufacture of sodium, primarily, and of aluminum, secondarily, were erected at Oldbury, near Birmingham. They were completed in July, 1888, and were alleged to have a very large capacity for producing aluminum. The reduction of aluminum at these works was conducted strictly on the lines of Deville's process—Castner's improvements being solely in the cheapening of sodium—and came to be known as the Deville-Castner process.

During the development of the various sodium processes to which I have above referred to, the possibility of utilizing electricity was not neglected. Among the earliest patentees in this field, were Camille A. Faure, in 1880–4, and R. Gratzel in 1883. Other inventors before those dates realized the value of electricity in smelting and other electro-chemical processes, but they were the first to give practical direction to theoretical speculation. Nothing has recently been heard of Faure's process, but that patented by Gratzel in Germany, in 1883, was practically utilized by a firm at Hemelingen, near Bremen, called the Aluminum and Magnesium Fabrik. The Gratzel process consisted, substantially, in electrolyzing a bath of fused chloride or fluoride of aluminum by means of anodes composed of a mixture of carbon and alumina, the current being furnished by a dynamo, but for some reason it was abandoned by the company, in 1887, for another process, the nature of which has been kept a profound secret.



A Heroult Crucible Used in Aluminum Extraction.

On April 2nd, 1889, Mr. Charles M. Hall, of Oberlin, Ohio, secured patents for a process of reducing pure aluminum. In this process alumina is dissolved in a fluid bath composed of aluminum fluoride and potassium fluoride, with, perhaps, an addition of lithium fluoride, this bath then being electrolyzed by means of an electric current conveyed to a carbon-lined furnace through an anode of some non-carbonaceous material. In electrolyzing this bath, the containing vessel is made to serve the purpose of the negative electrode. In another patent Mr. Hall claims the use of a bath composed of alumina dissolved in compound fluorides of aluminum with alkaline earthy metals, and in still another patent the use of a bath composed of alumina dissolved in the fluorides of aluminum, calcium and sodium, these materials being obtained by melting together aluminum fluoride, fluospar and kryolite. With this latter bath a carbon anode can be used without the bath being affected by its disintegration.

The Hall group of patents is now controlled by the Pittsburg Reduction Co., of Pittsburg, Pa., which has had its metal on the market since March, 1889. The plant has a capacity for producing about 300 pounds of metal daily, the selling price of which was $2.00 per pound, until the early part of March last, when it was reduced to $1.00 per pound for commercially pure aluminum of a guaranteed purity of 97 per cent. The reduction in price, considered in conjunction with the limited amount of pure metal produced would appear to confirm the generally received impression that while the pure metal is specially adapted to the manufacture of articles of art and ornament, it is not extensively displacing tin, platinum, silver, etc., to anything like the extent its admirers have supposed it would. The fact is, aluminum as a pure metal is not destined largely to supplant other metals in the arts and manufactures; it is to its alloys that we must look to redeem the inflated reputation of the pure metal. The true value and use of aluminum seems to have been forecast by Deville, who predicted for it an intermediate position between the precious and baser metals, in which relation to manufactures he said it was destined to fill a long-felt and important want. He doubtless referred to the pure metal, but, curiously enough, his prediction applies with greater force to its alloys, which have been demonstrated by actual use and thorough tests to possess physical and chemical properties that place them above all other alloys of copper, iron, and in some instances even of steel.

The electric smelting process of the Messrs. Cowles, of Cleveland, Ohio, was the first to secure a commercial footing in this country. The process may be described as the reduction of metals by smelting their ores with heat produced by the passage of an electric current through broken resistance material—that is, in the presence of an incandescent material, (carbon being generally preferred.) Stress is laid on the alleged fact that the reduction is purely and solely a smelting operation, due to a heat far greater than can be obtained by any agency other than the electric current. The electrical (chemical) effect of the current is distinctly disclaimed in their patents and publications. At each end of the furnaces are inserted rods of carbon. The charge consists, ordinarily, of a mixture (in different proportions) of an electrically resisting material—such as electric light carbon—and the ore to be reduced; though (in cases where the ore itself has sufficient electric resistance) the carbon is sometimes dispensed with. The current flows from the sides and ends of the electrodes through broken resistance material, which, of course, becomes incandescent. and the intense heat developed by this incandescence reduces the ore; the metal flowing to the bottom of the crucible and being subsequently dipped out when the charge is consumed. Neither aluminum nor any other metal is produced on a commercial scale by this process as pure metal.

The principal rival to the Cowles process for producing aluminum alloys is the Héroult process, which reduces aluminum and other metals from their refractory ores in the prescence of another alloying metal and is contradistinguished from the Cowles process mainly by the fact that it operates exclusively—or at least almost entirely—by utilizing the chemical or electrolyzing action of the current. This process is the invention of a young French electrical engineer named Paul L. T. Héroult, whose affiliations with the firm of Messrs. Henry Merle & Co., owning and operating the Deville Aluminum Works at Salindres, and his subsequent studies at the Polytechnic Schools at Paris and Switzerland, first directed his attention to the electrical reduction of aluminum. The success of a small Héroult plant put into operation at Boonton, N. J., for private demonstration purposes, in April, 1890, has been such as to give it rank among the prominent aluminum processes in this country. Having had exceptional facilities for studying the characteristics of this process during the past four months, I might be pardoned—especially as so little is publicly known of it—for describing it at length.

To give you a compehensive idea of the method employed by Mr. Héroult in manufacturing aluminum and its alloys, it will be best to describe the electrical plant and crucible separately.

The dynamo was designed by Mr. C. E. L. Brown of the Oerlikon works, Zurich, specially for electro-metallurgical work and is the only one of its kind in America. It weighs, complete over 19 tons and when driven at 220 revolutions generates a current of 35 volts and 35,000 amperes.

The machine is a 6 pole machine; having an armature of the Gramme ring type, and the current is taken off commutators at either end by 72 brushes. The armature is 39 inches in diameter and the shaft (including its clutch) is 11 feet 7 inches long. The commutators are each 19 inches in diameter and 20 inches long, each commutator containing 60 segments weighing 13 lbs. apiece, or a total of 780 lbs. for the segments for one commutator alone. The core of the armature consists of a very large number of sheet iron discs clamped together in a frame of aluminum bronze. About $\frac{3}{8}$ of an inch from the outside edge of the core, 120 holes pass from one end to the other, through each of which passes a copper wire ½ inch in diameter. These wires, which of course are thoroughly insulated from the core, form part of the winding. The remainder of the winding is composed of copper bars ¼ of an inch thick. 31 inches long and 2¼ inches wide.

At the time a friend visited the Schaffhausen (Switzerland) works last summer, where the Héroult process is worked by the Allgemeine Elektricitätsgesellshaft, of Berlin, who control the process in Europe, one of these 150 h. p. machines had been running without a moment's intermission 5 months, and another nearly

4 months. In actual work they are frequently run up to 300 revolutions, and though it sometimes happens in practical operations that heavy short circuits occur, there is hardly any perceptible sparking at the brushes, even when the current rises to 8,000 or more amperes.

At the Rhine Falls, at Froges, France, and at Boonton, these machines are coupled directly to turbine wheels arranged upon horizontal shafts. The frame to which the field magnets are attached is a solid casting, weighing alone over 9 tons. The field magnets are excited by a smaller dynamo driven by belting from a pulley on the main shaft. This exciting machine is run at 60 volts and 120 amperes.

At Boonton the bus wires are 8 in number; 4 positive and 4 negative; each wire being square and having a cross-section of one inch. The 4 positive wires pass directly to the clutch which holds the anode, and the 4 negative wires pass from the ammeter back to the dynamo.

The crucible (of which the accompanying engraving gives a good representation, together with the method now in use for raising and lowering the anode), is composed of a strong iron box which has a deep lining of carbon, previously ground very fine, mixed with sufficient tar and thoroughly compacted on the bottom and around the sides of the containing iron box. After the furnace is thus relined, the carbon is baked in order to drive away the tar and harden the lining. The carbon crucible itself actually forms part of the electric circuit. Héroult's is a continuous process; the reduced metal being tapped from the bottom of the crucible while the machine is merely stopped or slowed down for a few minutes. The interior dimensions of the crucible vary with the ore to be reduced, and the size and character of the anode used. Ordinarily it has an interior depth of about 22 inches and a clear space of 6 inches between the walls and exterior surface of the anode. The electric current passes into the crucible through the suspended carbon anode, the vertical position of which is controlled by an attendant who lowers it from time to time to preserve an approximately constant distance between the bottom of the anode and the surface of the molten bath in the crucible. In fact the anode usually dips several inches into this molten bath and in practice the intervening space between its bottom and the surface of the molten metal, is kept at about an inch by the attendant who, by watching the needle of the ammeter, is enabled to maintain the electrode in its proper relative position without difficulty. In order to get as perfect a contact as possible, between the furnace and the cables leading therefrom back to the dynamo, the cables are firmly clamped to a large block of zinc, which projects from the rear of the furnace and is kept cool by water circulating in pipes around which the zinc is cast. While, properly speaking, the crucible has no top, as a rule plates of carbon imbedded in dry alumina spread over the top of the crucible, are so adjusted as to fit close to the anode in order to retain most of the heat. The mouth of the crucible is formed of slabs of carbon built up funnel shape. The hearth or floor is pierced by a tap hole, which is kept closed by a plug of carbon or fire clay, and is opened from time to time to allow the molten metal to run into a carbon-lined ladle, from which it is cast into ingots.

There are a few distinctive but not important differences between Héroult's method of making alloys and reducing pure metals simply. In making alloys, the base alloying metal is first melted in the crucible by the current, or molten metal is poured into the furnace, to form a liquid metallic cathode. This is usually simply and economically accomplished by throwing pieces of the metal—copper for instance—into the furnace, seating the anode upon them and passing the current. At first the current is very unsteady, arcs constantly forming between the copper and the anode; but when the copper is entirely melted (and it takes but a very few minutes to melt 200 or 300 pounds) the ore to be reduced is added in sufficient quantities to form a bath, and floats on top of the molten copper. The anode having been raised so as to leave a space of about an inch between its bottom and the molten copper, the current becomes steady, and the operation is established. Thereafter the ore is introduced in small quantities, at frequent and regular intervals, until the desired percentages of aluminum or silicon contained in the alloy have been secured. This percentage can be regulated entirely at will up to about seventy per cent. of reduced metal. No external heat is used, and the process is absolutely continuous at the will of the operatives, which are special features of the Héroult system. The passage of the electric current through the bath, serves not only to keep the copper in a fluid state and to melt the ore, but also electrolyzes and decomposes the latter. It is a point of careful regulation in the Héroult processes to maintain only sufficient heat to keep the bath fluid, since any further expenditure is not only useless but lessens the output. The oxygen from the reduced metal combining with the carbon of which the anode is composed is burnt with the production of carbonic oxide gas, which escapes from the crucible around the sides of the anode and at the feed hole. The product is withdrawn at intervals by tapping the bottom of the crucible as in ordinary smelting. Each time the metal is tapped, a sample is carefully preserved for accurate analysis, to determine the percentage of contained aluminum.

From a metallurgical point of view, the amount of labor required to operate this process is astonishingly small. The metal produced in the Héroult furnace is sold generally in ingot form, just as it is tapped, without re-melting or being subject to any purifying manipulation. It is always, however, very pure, sometimes dropping as low as ninety-eight and one-half, but generally running over ninety-nine per cent. of absolute purity. This is largely due to the great care exercised in selecting raw materials. In making bronzes, the best Lake Superior copper is used, while the oxide from which the aluminum is reduced is an artificial product, manufactured in Prussia The number of materials from which aluminum may be reduced by these processes is very large, but the strong influence exerted upon this metal by impurities reduces those ores commercially available in this country to corundum and bauxite, both of which are largely used in making low grade metal for treating iron and steel. Kryolite—natural or artificial—is another mineral that plays an important part in the commercial production of pure aluminum, since it is the best flux for alumina, the ore from which the metal is generally reduced.

The very unusual qualities which give aluminum merit, and the great deprecation it undergoes when only slightly contaminated with foreign impurities, such as iron and silicon, together with the further fact that it has only been recently commercially produced of ninety-nine per cent. purity, have had a tendency to prejudice this metal in the eyes of practical people. From this depression it will slowly recover as they secure pure metal. In fact this very condition was foreseen by Deville, who very early pointed out that those handling aluminum and its alloys would be diappointed at the poor results they obtained where they used metal containing more than one per cent. of impurity.

Pure aluminum has a beautiful white color, slightly tinged with blue. It is somewhat fibrous in structure and bends considerably before breaking. If the metal contains more than one per cent. of impurity it becomes brittle and has a crystalline structure. When pure, it is soft enough to be easily cut with a knife, while the addition of a few per cent. of impurities makes it exceedingly hard. It melts at a slightly lower temperature than silver, and has a specific gravity of 2.6. Taking aluminum at 1.0 the following table (from Deville), will be of interest, as showing the compartive weight of the different metals:

Platinum	8.6
Gold	7.7
Lead	4.8
Mercury	4.2
Copper	3.6
Iron	2.9
Tin	2.8
Zinc	2.8
Aluminum	1.0

It has an elasticity similar to that of silver, and a tensile strength of about 26,800 pounds per square inch. The addition of 6 per cent. of copper, however, increases the tensile strength to that of wrought iron, and a slight percentage of silicon raises its strength to 90,000, though at the expense of other qualities.

The compounds of aluminum formed by the addition of copper, brass or iron, are unquestionably the most commercially important of the aluminum alloys. Aluminum combines with copper in all proportions, but its alloys are as easily influenced by impurities as is the pure metal. It is an important fact worth noting that, when alloys are made by mechanically mixing aluminum and copper, iron, etc., the product must be re-melted a number of times to secure any uniformity in the texture of the alloy. The finest alloys, by far, are those made by uniting the aluminum to the basic metal in atomic proportions, as it is reduced, as in the the Héroult process, the uniformity of whose alloys is remarkable. Probably the most useful compound of aluminum and copper is what is known as 10 per cent. bronze, containing 10 per cent. aluminum and 90 per cent. of copper. This alloy is an almost perfect imitation of gold in color, and is susceptible of taking and retaining a most beautiful polish. It can be rolled, or drawn, or cast very readily, but in casting, the bronze shrinks considerably, and care must be taken to have the feeders amply large. The tensile strength of this bronze is enormous, and the following table from "Trautwine Engineer's Pocket Book" shows it in comparison with other metals:

	Tensile Strength.
Cast brass	23,000
Annealed brass wire	49,000
Cast copper	24,000
Copper bolts	33,000
Annealed copper wire	32,000
Gun bronze of copper and tin (cast)	39,000
Cast-iron gun metal, U. S. Ordnance	30,000
Average American cast-iron	16,000
Good wrought-iron	50,000
Best American wrought iron, exceptional	76,000
Iron wires, rope	88,000
Malleable iron castings	48,000
Steel plates (rolled)	81,000
Cast steel, average Bessemer ingots	61,000
Aluminum bronze, in castings, over	100,000
Aluminum bronze "special" in castings up to	130,000

THE PROPAGATION OF HERTZIAN ELECTRICAL OSCILLATIONS IN AIR.[1]

BY MM. E. SARASIN AND L. DE LA RIVE.

We have already had the honor of presenting to the Academy the first results obtained by us on repeating the beautiful experiments of Hertz on rapid electrical oscillations. We confined ourselves on that occasion to the case of electrical oscillations transmitted along a conducting wire. Since then we have repeated another of Hertz's experiments, which consists in following the propagation of the electric induction across air in the absence of any metallic conductor. The primary exciter is placed in front of a large plane metallic sheet arranged parallel to it. The electric waves which emanate from it are propagated across the air, and impinge on the sheet of metal, which acts as a mirror, the reflected waves forming, with the direct waves, a stationary system, the first node of which is at the mirror itself. In order to study this system of wave outlines which is established in front of the mirror, a circular resonator is moved about in two different principal positions, (1) constantly parallel to the mirror and to the primary, *i. e.*, in the plane of the wave, (2) displaced into the plane drawn normally to the mirror through the axis of the primary, *i. e.*, in the plane of vibration. In both cases the results are absolutely concordant so far as concerns the equidistant positions of maximum and minimum E. M. F.'s. In addition to these two methods of proceeding, Hertz employed a third, which consisted in causing interference between waves arriving at the same resonator from the same exciter, either directly across the air or along a conducting wire. From these experiments he concluded, by the great wave length, that the rate of propagation across air in the absence of any conducting wire, was almost twice that observed along a wire, the two speeds being in the ratio of about 7.4. This disagrees with Maxwell's theory which makes the two speeds equal.

As reflecting surface we employed a large screen of sheet lead 2.8m. high and 8m. broad, kept plane and vertical by its own weight. The primary exciters and the large Ruhmkorff coils were the same that we employed in our previous investigations. The exciter was placed in front of the mirror, with its axis horizontal and its spark gap on the normal to the centre of the metal screen. Its distance from this was varied between 4m. and 10m. The circular resonator was fixed on a carriage sliding along a large wooden optical bench. We widely varied the conditions of the experiment, and repeated the observations a great number of times.

In these last investigations in air as in our previous ones with wires, we have, in fact, proved that *a circular resonator always gives the same wave length*, even when the dimensions of the primary exciter is varied within certain limits. We have, therefore, again observed what we have termed *multiple resonance*. In the case of large wave lengths (circles of 1 metre and .75 metre in diameter), which are very rapidly carried a long distance from the mirror and approach the direct action of the primary, one can only verify with any degree of precision one internode and node besides the node at the mirror itself. With smaller circles, for which the size of the mirror is more suitable, one can easily determine three internodes and nodes, including that at the mirror. The equidistance of the internodes and nodes is fairly satisfactory.

Our investigations show that the wave length obtained is in every instance sensibly equal in the case of propagation through air and along wires, the quarter of either wave length being nearly equal to twice the diameter of the corresponding circle. From this it follows that *the rate of propagation of Hertzian electrical oscillations, through air, is very sensibly the same as that of those transmitted along a conducting wire.*

College Notes.

UNIVERSITY OF KANSAS.

The Regents of the University have apportioned the appropriation for the ensuing fiscal year. The courses in civil engineering and electrical engineering have been removed from the College of Liberal Arts, and a School of Engineering has been established. Three thousand dollars have been appropriated for the further purchase of apparatus for electrical engineering. More than forty students are taking the electrical-engineering course at Lawrence this year.

The Thomson-Van Depoele Co. have shipped a 40 h. p. electric locomotive to the Rocky Mountain district and a 75 h. p. locomotive to the coal fields of Pennsylvania, both with full equipment for traction purposes. These machines will be used for underground haulage.

Literature.

Appleton's School Physics. By J. D. Quackenboss, A. M. Mayer, F. E. Nipher, S. W. Holman and F. B. Crocker. New York: *American Book Co.*, 1891. Cloth, 544 pp. 5x7¾. Illus. Price, $1.20.

This is in every way an admirable publication—the best of its kind for all pupils up to the age of 15, and, for that matter, a book which can be read with profit by many who are unfamiliar with modern ideas and discoveries in natural philosophy. A work that aims as this does to give the latest information in every branch, must necessarily be the production of more than one writer, and hence we find the different departments allotted with judgment to men who are specialists and experts in each case. A common error in the preparation of school books of this nature has been to entrust all the work to one hand, and the consequence has been that while upon a superficial examination, and to the uninformed, the whole might seem attractive and accurate, a scrutiny of any single section by those skilled in it revealed either numerous mistakes or statements of the "back number" type.

We have not looked very critically into the parts of the book beyond our own province, but judging them by the performance in the sections on electricity and magnetism, they must all be extremely well done, rendering the book about as near perfection as could be desired. The part on frictional and voltaic electricity has been handled by Prof. F. E. Nipher, and that on magnetism and the practical applications of electricity has been treated by Prof. F. B. Crocker. The young student cannot but feel as he goes over these chapters that he is in closest touch with a great science and an expanding industry, and that whether he would investigate or invent, electricity is to him another name for opportunity. The stages by which the work proceeds are also happily arranged, for after he has mastered the principles of sound, heat, light, etc., the young beginner comes to understand the relation to these phenomena of the steam engine, the dynamo, the battery, the electric light, the telegraph and the telephone. All is modern in treatment, all is fresh and down to date.

A word of praise is also due the illustrations, which are new and thoroughly helpful in elucidating the text. In typography, the arrangement is also to be commended.

Formulaire Pratique de l'Electricien, 1891. By E. Hospitalier. Paris, G. Masson, Price, $2.00.

M. Hospitalier's Electricians' Pocketbook has always found a welcome place on the work table of the electrical engineer and in this year's edition he has, if anything, made it more valuable than before. To this year's edition there has been added considerable matter that had been excised from former editions on account of lack of space, but in addition to this the part devoted to theory has been largely augmented by many valuable data on periodic currents. In the practical part considerable information has been added on specific resistance of metals, alloys and liquids, and the values of the principal magnetic constants of the steel employed in the manufacture of permanent magnets. Much new matter is also to be found on the distribution of currents and many practical figures on the construction of dynamos, transformers, etc. The work as a whole contains information which we have not seen embodied in any other one work intended for this purpose.

Steam: Its Generation and Use. New York, 1891. *The Babcock & Wilcox Co.* Illustrated, 152 pp.

This is the twenty-third edition of an admirable trade manual and catalogue. The first edition appeared in 1879, since which time the book has grown in bulk and value until it has now become a complete and most instructive treatise on a most important topic. The present issue, a handsome, freely illustrated, well-bound volume of 150 pages, contains not a little new matter of interest, including Mr. G. H. Babcock's pithy Cornell paper on the circulation of water in steam boilers; a table with formula on equation of pipes; and a revised table, due to Prof. C. H. Peabody, of the properties of saturated steam. During the past few years, Mr. Babcock, in a series of papers and lectures, has developed a complete theoretical and practical system of steam generation, and these are all given here in extenso, constituting a valuable body of data without which the literature of the subject would be sadly deficient.

We note in the statistical part, that the company's boilers, in connection with electric lighting work, have found their way all over the world, and that some of the stations run up to as much as 4,000 and 6,000 h. p. of boiler capacity. In the new work of electric railroading, the company has already a capacity, roughly totalled, of nearly 20,000 h. p.—a striking instance of the manner in which electrical engineering at each advance carries with it a larger promise and field for steam engineering.

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[1] From the *Comptes Rendus*, Vol. CXII, No. 13.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the monthly meeting of the Council of the Institute, the following gentlemen were admitted to associate membership:

Alexander, Henry, electrical contractor, 340 West 145th street, New York City.

Bedell, Frederick, graduate student, Cornell University, 118 Elm street, Montclair, N. J.

Bottome, Turner D., electrician and general manager, White House Mills, Hoosick, N. Y.

Bourne, Frank, electrical engineer, the Field Engineering Co., 15 Cortlandt street, New York City.

Burleigh, Chas. B., 620 Atlantic avenue, Boston, Mass.

Burton, Geo. D., president, Electrical Forging Co., 194 Washington street, Boston, Mass.

Casper, Louis, Wheatstone Repeater Chief, Western Union Telegraph Co., Cheyenne, Wyoming.

Clement, Lewis M., 1013 Central avenue, Oakland, Cal.

Cogswell, A. R., electrician and superintendent, Halifax Illuminating and Motor Co., Ltd., 34 Bishop street, Halifax, N. S.

Dunn, Gano S., student in electrical engineering, Columbia College, 66 West 93rd street, New York City.

Foote, Allen R., special agent, electrical industries, U. S. census, Washington, D. C. P. O. Box 432.

Foote, Thos. H., 104 Columbia Heights, Brooklyn, N. Y.

Hart, Francis R., superintendent of construction, Mass. Electrical Engineering Co., 4 P. O. Square, Boston, Mass.

Henry, John C., electrical engineer, 114 East 54th street, New York City.

Hering, Herman S., professor of applied electricity, Philadelphia Manual Training School, 553 North 16th street, Philadelphia, Pa.

Herrick, Charles H., manager and electrical engineer, Wright Electrical Engineering Co., 196 Summer street, Boston, Mass.

Holmes, Franklin S., electrical engineer with C. H. Davis, 120 Broadway, New York, 445a Macon street, Brooklyn, N. Y.

Johnston, A. Langstaff, civil and consulting engineer in the general construction of electric railways, 1105 East Main street, Richmond, Va.

Lovejoy, J. R., electrical engineer, Thomson-Houston Electric Co., 620 Atlantic avenue, Boston, Mass.

Schmidt, Giacomo, assistant general manager, Richmond Light, Heat and Power Co., New Brighton, N. Y.

Sheeby, Robert J., electrical engineer, Equitable Mfg. and Electric Co., 24 West street and 101 West 76th street, New York City.

Shepardson, George D., instructor in physics, Cornell University, Ithaca, N. Y.

Spaulding, Hollon C., secretary, Thomson-Van Depoele Electric Mining Co., 620 Atlantic avenue, Boston, Mass.

Tottingham, F. M., superintendent 2nd district, Edison Electric Illuminating Co., 49 West 26th street, New York City.

Thompson, Alexander, superintendent electrical department and chief engineer, Superior Water, Light and Power Co., West Superior, Wis.

Van Wyck, Philip V. R., Jr., 36 West 12th street, New York City.

Webster, Edwin S., Massachusetts Electric Engineering Co., 4 P. O. Square, Boston, Mass.

NEW YORK ELECTRICAL SOCIETY.

The next meeting of the Society will be held on April 30, at 8 p. m., at Columbia College, in Prof. Chandler's room, when Mr. Chas. Steinmetz will lecture on "The Elementary Principles of Designing Alternating Current Apparatus." The lecture will cover the whole ground in a popular and helpful manner, and should not be missed by anyone who is beginning to make a study of this important subject. Apparatus and current will be employed.

FRANKLIN EXPERIMENTAL CLUB.

The Thirtieth Regular Meeting of the Franklin Experimental Club of Newark, was held at the Club Laboratory, No. 6 Bloomfield Ave., April 21. Francis R. Upton read a paper entitled, "The Possibilities of Electricity." He described his early experiences in the electrical field when he first became associated with the developement of the incandescent lamp at Menlo Park. He declared that the growth of that industry in extent and efficiency, a growth with which his own business career was closely allied, made him feel prophetic in regard to the future. He stated that the incandescent electric light offered a most promising field for investigation.

Mr. Upton then took up the subject of heating and said that electricity was, theoretically, a perfect agent for the purpose: that it was even now possible to furnish electrically generated heat for domestic purposes and that it only remained to so reduce the cost of producing heat electrically as to place it on a commercial basis.

The speaker went into the subject of the generation and maintenance of power on a large scale, and which could be transported at will, and distributed in any desired amounts. Electricity, alone of all forces, has solved this problem.

The question of rapid transit was then taken up; also the advance being made in long distance telephony.

Mr. Upton brought his paper to a close with the prediction that New York would become the great electrical centre of the World, and that the city's growth and development would offer unprecedented opportunities for electrical expansion.

A general discussion followed and was participated in by Messrs. Wm. J. Hammer, Geo. B. Webb and Dr. T. W. Corwin.

Some novel incandescent lamp experiments were shown by F. W. Hillard and Paul H. Jaehnig.

At the next meeting of the Club, the first Tuesday in May, a paper will be read by Wm. J. Hammer, entitled "The Arc Light."

Legal Notes.

A "DOUBLE CARBON" INJUNCTION DENIED IN NEW ORLEANS.

In an elaborate opinion, Judges Pardee and Billings of the Federal courts, have denied the injunction sought to be obtained by the Southwestern Brush Electric Light and Power Company against the Louisiana Electric Light Company and the Brush Electric Light Company.

The suit was brought against the Louisiana Company for infringement of patent No. 219,208, which was granted to Chas. F. Brush, September 2, 1879, on "double carbon" arc lamps.

The court held that an injunction, as asked for, would temporarily, at least, until substitutes could be supplied, compel the Louisiana company to stop business, breaking its contract with the city, as well as private consumers, to the great injury and inconvenience of the public. Further than this, it appeared that even if the Louisiana Company could carry out its contracts by using single lamps, still the inconvenience and injury to the public would be great, because of the poor service while making the change, and thereafter while trimming the lamps in the middle of the night, and still greater because of the danger necessarily resulting to the agents engaged in the nightly duty of trimming the lamps while the conducting wires are heavily charged with electric currents.

The case presented was thus one where the benefit to the complainant was doubtful, and where the injury to the public and defendant were certain.

The court next cited numerous authorities bearing upon the rules governing the discretion of the court in granting or refusing injunctions in cases similar to this one.

The complainant company having introduced the double carbon lamps into public use, and the public having found them necessary to public safety as well as convenience for business purposes, a court of equity should not deprive the public of such use, at least on a preliminary hearing, and as the suit of a complainant who was in no condition to supply the public demand at any cost or expense, and who was destitute of pecuniary means and all apparatus to such a degree as to make it reasonably certain that an injunction causing such public inconvenience would be of no benefit to the parties obtaining it.

Affidavits of Messrs. Thos. L. Airey, Isidore Newman and others, capitalists and stockholders of the complainant company, show that the only remaining asset of the company is the patent, and that it is valuable if it can be protected.

In conclusion, the court says: "We are clear that the injunction *pendente lite* should be denied, and it is so ordered."

Messrs. J. R. Beckwith and H. L. Lazarus represented the complainants, and Messrs. R. S. Taylor and Farrar, Jones and Kruttschmitt the Louisiana Company.

ELECTRIC CUT-OFFS.

In the suit of David Rousseau *vs.* A. L. Bogart, the defendant has voluntarily consented to the entering of a decree, on April 20, in favor of plaintiff, the latter agreeing to waive all accounting and damages by the defendant and his customers in the past.

The suit involved the right to the manufacture of electric cut-offs having electro magnets and clock movements, under the following patents: D. Rousseau, June 5, 1883, 279,107; W. H. Sawyer, June 7, 279,073; Jacob Tirrell, Aug. 14, 283,303.

A similar suit is now pending in the U. S. Circuit Court for the Southern District of New York, against the Electric Gas Lighting Co., of Boston, which, it is stated, will be thoroughly defended, until a final decision by the court is reached.

Reports of Companies.

ABSORPTION OF THE BERGMANN MANUFACTURING CO.

The following notice to the trade has been issued by E. H. Johnson, president of the Interior Conduit and Insulation Co., and S. Bergmann, president of the Bergman Co : "The Interior Conduit and Insulation Company having acquired the entire property, patents and good will of the Bergmann Manufacturing Company, will henceforth prosecute as a branch of its regular business all that class of work heretofore done by the Bergmann Manufacturing Company. With the increased facilities and capital thus acquired, together with the continued association of the undersigned, you are assured that the well won reputation of the past for good and prompt work will not suffer in the future at the hands of the new company, which herein solicit a continuance of your favors."

ORGANIZATION OF THE THOMSON-HOUSTON FACTORY WORK.

Some important changes have recently been made in the manner of carrying on the work at the huge Thomson-Houston factories in Lynn. In order to be free to give more attention to the many important questions concerning the design of apparatus, and general questions of vital importance in the management of the works, and to avoid detail work as much as possible, Mr. E. W. Rice, Jr., the superintendent of the factory, has practically placed the management of the routine work there in charge of a manufacturing committee, as follows :

Mr. I. F. Baker, as "Mechanical Superintendent," in charge of all mechanical work, general discipline, construction, etc.

Mr. D. M. Barton, as "Production Manager," in charge of the entire output of the factory, which consists in balancing the production against orders and also keeping the factory supplied with raw material.

Mr. G. E. Emmons, as "Factory Auditor," in charge of the book-keeping, estimating, piece-work accounts and general labor accounts of the factory.

The positions occupied by these gentlemen are practically the same as they have been filling during the past three years, only with increased responsibilities, the three also acting as an executive committee, with full powers, to manage the factory in Prof. Thomson's absence.

The Mr. Barton mentioned above is a brother of Silas A. Barton, the former General Manager and Assistant Treasurer, now President of the Brush Electric Co.

Mr. Rice's position will be as hitherto, that of General Superintendent in general executive charge of manufacturing and technical work at the factory. It is also expected that he will have more time than in the past to visit the other factories of the Thomson-Houston Electric Co. and help to introduce as far as practicable any improved methods of management, manufacture or design of apparatus, found in the Thomson-Houston Electric Co. or its allied interests.

THE PUMPELLY STORAGE BATTERY CO.

Pursuant to a resolution of the Board of Directors, the assets of the Pumpelly Storage Battery & Electric Motor Co. will be sold at auction on April 30th, 1891, at 10 o'clock A. M., at the East front of the Springer Building, Nos. 205 & 207 South Canal St., Chicago Illinois, to the highest bidder for cash. The property to be sold consists of the patents, bills and accounts receivable, machinery and all other property and rights of the Company of every kind.

ELECTIONS.

Windsor Locks, Conn.—At the annual meeting of the Windsor Locks Electric Light Company, these directors were chosen : Charles E. Chaffee, Ezra B. Bailey, J. R. Montgomery, William Mather, J. H. Adams, Allen Pease, Samuel McAuley, E. D. Coogan and Henry C. Douglass. The directors chose these officers : President, Ezra B. Bailey ; vice-president. J. R. Montgomery ; treasurer and general manager, William Mather; secretary, Henry C. Douglass.

STOCKS AND BONDS.

San Jose, Cal.—The San Jose Light & Power Co. has voted to issue $60,000 worth of bonds to enlarge its works for gas, electric lights and power.

Talladega, Ala.—The Talladega Light Co. is considering the question of issuing bonds.

Burlington, Ia.—The Burlington Street Railway has become the Burlington Electric Railway Co., and announces an issue of 6 per cent. first mortgage bonds for the purpose of equipping the road with electricity.

Appointments, Etc.

Mr. H. F. **Parshall** has been placed in charge of the street car motor designing and construction, at the Edison General Works, Schenectady.

Mr. **Louis Walsh**, late of the Crosby Electric Co., has been appointed manager of the battery and carbon department of Alexander, Barney & Chapin, of this city, and has already entered upon his duties.

Mr. J. B. **Avery** is now in full charge of the Norwalk, Conn., Electric Light Co.'s plant, succeeding Mr. Bonnell as superintendent.

THE BERMUDA CABLE.

Mr. A. Livingston Bogart, electrical engineer, has just returned from Bermuda, greatly improved in health. He reports that Mr. Rippon, the manager of the Halifax-Bermuda cable, is busy on plans for the extension of the service. The enterprise so far has been a satisfactory one as an investment. The rates are high, being 81 cents per word, and the question of lowering the tariff is now under discussion. Some interesting telephonic tests over the cable were made by Mr. Bogart, and Mr. Ferguson, of the local telephone company, but they did not yield results.

A LONG STRAIGHT LINE OF ELECTRIC ROAD.

Mr. C. C. Upham, the manager of the Salt Lake Rapid Transit Co., writes us that they are now extending their line in Salt Lake City to the smelters. The distance on a straight line without a curve will be 7 miles, all on State street. While this is not by any means the longest line in one general direction, it is probably the longest piece of straight line in the country.

"BOY WANTED."

Mr. Samuel L. Powers, representing the New England Telegraph and Telephone Company, said recently that his company had the right to be recognized as a public servant, inasmuch as the messages which it carried would require the employment of ten thousand messenger boys. The free privileges which it accorded to cities and towns would require, on the part of the municipalities, an outlay for the plant of $300,000, and in addition it cost the company from $30,000 to $40,000 a year to maintain this gratuitous service.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of April 25, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	82⅜	Edison Gen. Elec. Co	98¼
American Tele. & Cable	83	Consol'd Elec. Lt. Co	....
Centl. & So. Amer	145	Edison Illn'g Co. N. Y	76
Mexican	205	U. S. Elec. Lt. Co	80
Com. Cable Co	105	North Am. Phonograph	. ..
Postal Tel. Cable	89		

BOSTON.

	BID.		BID.
Thomson-Houston	47¼	Ft. Wayne Co	13¼
" Pref'd	25¼	Am. Bell	205
" Series C	9	Erie	49
" " D	7⅛	New England	50¼
" Int. Co	....	Mexican	.95 cts.
Thomson Welding Co	....	Trop. American	.85 cts.
Thomson Eu. Welding	55	Edison Phon'gph Doll	....
Detroit El. Works	13¼		

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	175
Ches. & Pot. Telephone	57	Eck.&Sold. Home Elec.Ry.	55¼
Amer. Graphophone	5¼	Georgetown & Tenallytown	63

*Ex. Dividend.

PITTSBURGH.

Westinghouse El. Man. Co.	13⅜

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 21, 1891.

Accumulators :—

Method of Making Plates of Secondary Batteries, S. C. C. Currie, 450,884. Filed Nov. 18, 1890.

Comprises, essentially, a tube of woven material surrounding an interior conducting support, and between, upon, and into which is cast a porous crystallized metallic mass. Employs the fused salt or salts of a metal for the mass cast around the supports.

Alarms and Signals :—

Electric Bell-Pull, L. B. Tinkham, 450,706. Filed Oct. 11, 1890.

A device adapted to be applied to the shank of any ordinary bell-pull without altering or fitting the shank.

Thermostat, J. C. Sims, 450,896. Filed Nov. 29, 1890.

A thermostat of the class in which a thermometer or mercury tube having a series of contacts at different points is employed.

Conductors, Conduits and Insulators :—

Insulator, T. Creighton, 450,708. Filed June 19, 1890.

Intended for use in connection with telegraph wires, lightning rods, etc.; integral in all its parts; head has an angular groove and a direct transverse central pole to receive an ordinary lightning rod.

Electric Cable, W. I. Bunker, 450,784. Filed Oct. 7, 1890.

The conductor is composed of a series of particles (shown as spheres or rectangular blocks in the drawings) adapted to make contact with each other or to be separated from each other to break contact by bending or otherwise moving the cable.

Method of and Apparatus for Covering Electric Wires, J. E. Walcott. 450,830. Filed Sept. 30, 1884.

For covering insulated wires or cables with sheet metal; consists in bending a strip around a wire or cable and forming lips or raised edges upon the strip and then burning the edges together.

Dynamos and Motors :—

Electric Motor or Generator, J. F. Seiberling, 450,689. Filed Nov. 17, 1890.

Relates to the construction of the pole-pieces of the field-magnets in two parts, adjustable in relation to each other, and with faces adjustable at the sides of the armature; also includes details of the armature to facilitate removal and repair of its parts.

Self-Exciting Alternate-Current Electric Generator, W. Stanley, Jr., 450,641. Filed Oct. 19, 1888.

Designed to maintain a constant or an increasing or decreasing difference of potential upon the work-circuit throughout variations of load.

Claim 1 follows:

In a self-exciting alternate-current electric generator, the combination of two or more independent sets of armature coils, an electric converter wound with two independent coils, one connected in series with the field-magnet coils of the generator, the other in series with the work-circuit, each arranged to lessen the self-induction of the other, said converter being mounted upon the armature shaft and revolving therewith, and a rectifying commutator interposed in the field-magnet circuit.

Dynamo-Electric Machine or Motor, A. L. Parcelle, 450,975. Filed Oct. 14, 1890.

Relates to multipolar dynamos with ring armatures rotating about radial field-poles. Designed particularly for slow speed motors. Each field-pole acts simultaneously upon a number of armature coils.

Electric-Current Regulator, J. A. Williams, 450,985. Filed Nov. 15, 1890.

Consists in the employment of a compound thermostatic bar with the circuit wires of the dynamo and a pair of compound thermostatic bars oppositely arranged with respect to each other and connected with the movable brush holder; current shifting devices are arranged to throw the current into one or the other of the secondary compound thermostatic bars.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, C. Willms, 450,840. Filed Dec. 16, 1890.

Relates to the class of small portable batteries with sealed cells, and consists in details of construction of cell-cases for such batteries.

Lamps and Appurtenances :—

Socket for Incandescent Lamps, G. H. Alton, 450,605. Filed Oct. 22, 1890.

Details of construction.

Wall Socket for Incandescent Electric Lamps, P. Lange, 450,698. Filed June 11, 1890.

For supporting an incandescent lamp upon a wall and where it is not required to interrupt circuit connection at the lamp itself.

Ceiling Rosette for Incandescent Lamps, D. J. Cartwright. 450,991. Filed Nov. 10, 1890.

Details of construction.

Medical and Surgical :—

Clamp-Electrode for Electrical Dental Apparatus, T. S. Wilson, 450,690 Filed Oct. 22, 1890.

For securing the hold of an electrode in the hands of a patient during the act of treatment by electricity.

Miscellaneous :—

Safety Device for Overhead Electric Wires, M. Kerstein, 450,696. Filed Jan. 30, 1891.

For application to electric light wires; on the accidental breaking of a wire the broken end will be automatically insulated, rendering it harmless in case it falls upon another wire or upon any object or person.

Electric Valve Controller, C. B. Reardon, 450,872. Filed June 4, 1888.

Designed to enable a fireman holding the hose nozzle to control the flow of water through electro-magnetic devices.

Electrically Propelled and Steered Torpedo, W. S. Sims, 450,875. Filed Dec. 22, 1890.

The torpedo is directed from the shore through an electric cable; employs a steering magnet, and a generator on shore, a relay for directing current through the steering magnet, a resistance in a shunt around the relay contacts, and means for opening the shunt after the relay contacts are separated.

Electro-Magnetic Apparatus, L. G. Woolley, 450,923. Filed Aug. 16, 1890.

Included a battery, an electro-magnet, a primary and secondary coil, all so arranged that the primary current may be available for operating electrical apparatus such as annunciators, thermostats, etc., and the induced current may be available for medical purposes.

Automatic Electric Valve Controller, F. E. Chatard, 450,927. Filed Jan. 15, 1891.

Adapted for controlling the heating apparatus in buildings.

Electric Switch, J. A. Norton, 450,972. Filed Sept. 26, 1890.

Relates particularly to double-pole switches controlling both the flow and return wires of a circuit; is a spring acting switch and includes a novel form of terminals.

Railways and Appliances :—

Electric Railway, F. S. Culver, 450,613. Filed Sept. 25, 1890.

Relates to the traveling contacts; aims to provide a light and easy running two or four-wheel trolley, adapted to engage yieldingly both wires of a double circuit in which one wire is above the other; also includes an automatic switch and crossing.

Railroad Signaling Apparatus, J. D. Taylor, 450,645 Filed July 18, 1890.

An improvement on the invention patented to the same inventor Jan. 28, 1890, No. 420,235.

Electric Railway Block Signal, J. D. Taylor, 450,646. Filed Sept. 9, 1890.

Intended to give the control of trains on any system of blocks into the hands of one man, so that he may know the exact location of all trains.

Electric Locomotor, G. Westinghouse, Jr., 450,652. Filed Aug. 1, 1890.

Designed especially to secure the requisite friction between the car-wheel and track rails for carrying heavy loads and ascending grades. A main-truck receives the greater share of the weight; a pony truck may be placed near one end of the car, serving to steady its movements. The weight of the car is so distributed that the greatest pressure is normally upon that pair of main-truck wheels to which the driving power is directly applied; when the greatest power is required, for unusual load or for grades, the second pair of main-truck wheels is coupled with the first pair by interposed friction wheels, the pressure of which upon the truck wheels is determined by the torque exerted by the motor.

Trolley or Traveler for Electric Railways, S. H. Short, 450,683. Filed Apr. 9, 1890.

Relates to trolleys for making separate contact with two overhead conductors connected with opposite poles of the generators.

Railway Gate Crossing for Overhead Lines, E. Thomson, 450,687. Filed May 5, 1890.

Provides means for closing the line or giving the trolley a path when a car reaches the point of crossing.

Electrical Propulsion of Vehicles, E. H. Johnson, 450,742. Filed Aug. 8, 1890.

Adapted to regulate the power applied proportionally to the work required, and particularly to apply the power gradually at the time of starting the car: consists broadly in successively closing circuit from two or more electric motors mechanically connected to the wheels of a vehicle.

Insulated Electric Car, J. Stephenson, 450,846. Filed July 5, 1890.

Consists in means for insulating the car-body with its contents from all parts of the car that are in circuit or liable to be affected by the electric current.

Trolley-Wheel Support for Electric Cars, H. A. Webber, 450,853. Filed Aug. 18, 1890.

Adapted to permit a ready swing movement of the bearing in which the wheel is arranged without liability of cramping, and at the same time secure a perfect contact between the trolley-wheel and the conductor.

Electric-Motor Mechanism, S. E. Mower, 450,970. Filed Nov. 4, 1890.

Relates to means of transmitting power from an electro motor to the driving axle or axles of the car; employs a countershaft, gearing connecting the the armature and countershaft, a sprocket-wheel loose on the countershaft, a sprocket wheel on the axle and mechanism to render the sprocket-wheel fast on the countershaft.

Telegraphs :—

Means for Communicating Information, P. B. Delany, 450,615. Filed Nov. 26, 1888.

A visual signaling system by which news or matters of interest may be communicated to observers at a distance at night or in the dark. A transparency having letters of the alphabet and numerals upon its face is provided with electric lamps, one behind each letter or numeral, and which can be severally flashed from a transmitting station.

Printing Telegraph, S. R. Linville and L. F. Hettmansperger, 450,630. Filed June 23, 1890.

A system in which the instruments can be operated either as transmitters or receivers by alternating currents, transmitted through a single conductor from a source of electrical energy located either at a terminal station or at an intermediate station.

Printing Telegraph, S. R. Linville, 450,631. Filed Aug. 12, 1890.

An exchange telegraph system affording means of inter-communication between a number of subscribers connected to a central station.

Obituary.

PHILIP L. MOEN.

Philip L. Moen, President of the Washburn & Moen Manufacturing Company, died at his home in Worcester, Mass., on April 23. He returned home from a Southern trip a few days ago very much exhausted, and on Monday he suffered a stroke of apoplexy, with resulting paralysis. He did not rally from the shock. Mr. Moen was at the head of the biggest wire manufacturing establishment in the world. The company had big mills in Worcester, which employed 3,500 men, and had recently purchased a large tract of land at Chicago, where it is about to erect a large plant to make wire for the Western trade.

Mr. Moen was born at Wilna, N. Y., Nov. 13, 1824. He began business life as a clerk in a hardware store in this city, whose owners were the selling agents for the wire manufactured by Mr. Ichabod Washburn in this city. Young Moen married Mr. Washburn's daughter in 1846. Soon after he went to Worcester, and in 1850 was taken into partnership by his father-in-law under the style of I. Washburn & Moen, which continued the firm's name until 1868, when the present corporation was formed.

Upon the death of Mr. Washburn in 1870, Mr. Moen became President of the corporation, which position he since held. He was an exceptionally well-equipped business man, and under his management the corporation has prospered, especially since it purchased the barbed wire patents. He was always interested in educational and charitable enterprises, and gave liberally. He was a member of the Board of Trustees of the Worcester Polytechnic Institute. The company of which he was the head has been a very large manufacturer of wire for electrical purposes.

TRADE NOTES AND NOVELTIES

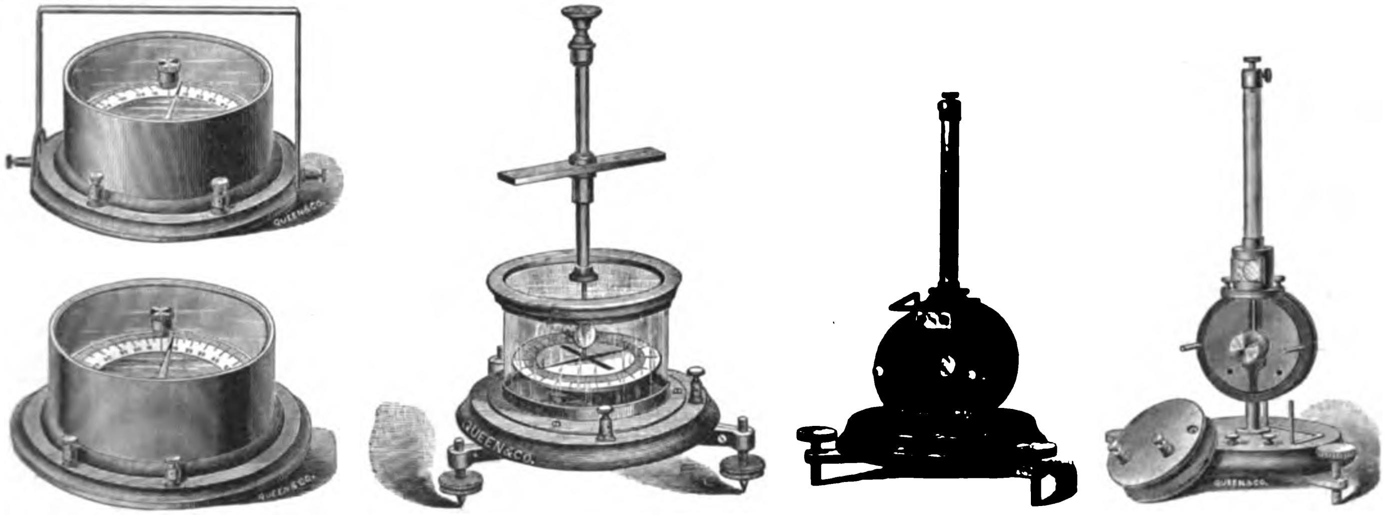
AND MECHANICAL DEPARTMENT.

A good advertisement is addressed to the eye, the mind, and the pocket, and captures all three at once.

ELECTRICAL MEASURING INSTRUMENTS FOR SCHOOLS.

Electrical science has made such rapid advances that untrained skill is no longer of much avail, nor have the colleges themselves been able to properly do all that is required of them in keeping at the head of investigation, while, at the same time, attempting to give elementary instruction. As a consequence each year sees more and more of this elementary work relegated to the high schools and preparatory institutions. Most of these schools, however, supported by municipalities or by private endowment, are unable to purchase the orthodox high grade testing instruments, even were it desirable to put such extremely delicate apparatus in the hands of beginners.

The accompanying illustrations show a number of electrical testing and measuring instruments, designed and put upon the market by Messrs. Queen & Co., of Philadelphia, expressly for the use of schools and students beginning laboratory work. These, while capable of doing very nice and accurate work, are especially adapted to the use of beginners, as they are strongly made and have their delicate parts so arranged as to be easily and quickly replaced in case of injury.


QUEEN&CO.
QUEEN&CO.
QUEEN&CO.
QUEEN&CO.

FIGS. 1, 2, 3, 4, 5.—ELECTRICAL MEASURING INSTRUMENTS FOR SCHOOLS.

In these instruments all unnecessary and superfluous finish has been avoided; at the same time, they are neat and well made and will not appear out of place in the best appointed laboratories.

The list, as published by Messrs. Queen & Co., is a most complete one, and includes all the instruments necessary for a thorough first year's course in laboratory electricity. Fig. 1, shows a neat form of horizontal galvanometer for ordinary work; this style is furnished with different windings, so as to measure, currents ranging from 0.01 to 40 or 50 amperes. Fig. 2, is the same thing with a heavy copper strip moving over a graduated arc, thus allowing the measurement of heavy currents and the demonstration of the laws of the cosine galvonometer. Fig. 3, is a fiber suspended galvanometer, pivoted on a vertical axis, for use as a sine galvanometer. Fig. 4, is a reflecting galvanometer of the Thomson type, in which a small brass cylinder with a glass face may be pushed backward and forward in the central axis of the coils, thus altering the size of the air chamber in which the mirror swings, and enabling the deflections to be made very dead beat. Fig. 5, is another "dead beat" galvanometer, of the Edelmann type; the mirror being attached to a bell magnet moving in a mass of copper. By removing this mass of copper the instrument is made ballistic, thus making it useful for measurements of condenser capacities, battery resistances, comparison of electromotive forces, etc. The coils are readily removable, as seen by the illustration, and may be changed in a moment for others of a higher or lower resistance. Both these last two styles of galvanometers are furnished wound to high or low resistances, as required.

A neat 16 page catalogue, I-70, of all this apparatus is issued by Queen & Co.

ADHESIVE BELT DRESSING.

It is of prime necessity to a central station man to keep his belts in good order, and the article manufactured as a belt dressing by E. F. Houghton & Co, of 211 So. Front St., Philadelphia, is intended to assist them in this respect. It is in use with much success by a large number of local companies all over the country. It is not a grease, but a bright oil, a little of which lightly applied by brush or sponge will have its effect in keeping the belt clean and in making it at once more flexible and durable. Owing to the increased grip on the pulley, given by its use, slipping is prevented, and higher economy is attained in the operation of the machinery and the steam plant.

HARRISBURG IDE AND IDEAL ENGINES.

A brisk and vigorous business is being done by W. R. Fleming & Co., 174 Fulton street, New York, in steam plants and power transmission machinery. During the past two weeks orders for some fifteen "Ide" and "Ideal" engines, together with other contract work, have been taken, inclusive of the following: One 500 h. p. Ide cross compound, New England Engineering Co., Waterbury, Conn.; one 75 h. p. Ideal, Pratt & Whitney Co., Hartford, Conn.; two 150 h. p. Ide tandem compounds, Somerville Elect. Lt. Co., Somerville, N. J.; one 150 h. p. Ide tandem compound, Hackensack, N. J.; one 25 h. p. Ideal, Tarrytown, N. Y.; two 100 h. p. steel boilers, with Weltmeyer patent furnaces, for Long Island City Elec. R. R.; four contracts for shafting and friction pulleys, manufactured by William Sellers & Co., and Moore & White Co., of Philadelphia, whose agents W. R. Fleming & Co. are. All of the above plants are equipped with the celebrated Jewell belting, which company they also represent. Several engines of well-known makes have been taken out in the above plants, and some bargains may be had to parties looking for second-hand machines.

CROCKER-WHEELER ELECTRIC MOTOR CO.

A visit to the headquarters of the Crocker-Wheeler Electric Motor Company, 430-432 West 14th street, New York, will show them at the mercy of carpenters and painters who are re-arranging and renovating their recently enlarged establishment. The alterations being made are now nearly completed, and promise an improvement in the appearance and convenience of the premises. Trade is good with this enterprising concern, and the outlook for the future is decidedly rosy.

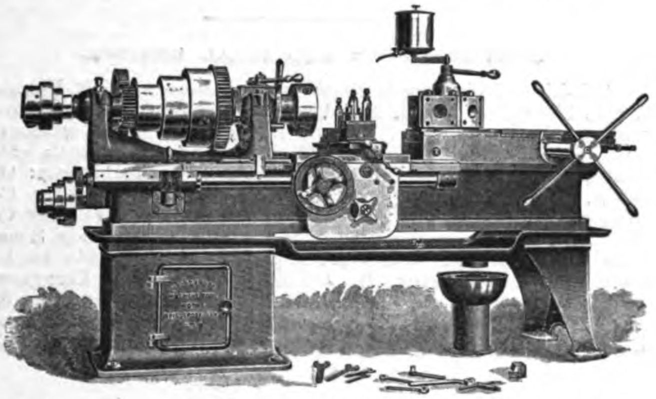
A FEW WORDS ABOUT GRAPHITE PAINT.

The life of an ordinary roof or outside paint runs all the way from two to five years, and it should be of personal interest to many to know of a paint that will resist acids or alkalies and withstand the wear and tear of the elements for 10 or 15 years. This seems to be a remarkable length of time, but the statement is vouched for by well-known people who have used Dixon's Graphite Paint made by the Jos. Dixon Crucible Co., of Jersey City, N. J.

They claim that Graphite Paint is not only durable but handsome and equally useful for all outside wood or metal work where a dark paint can be used.

A NEW SCREW MACHINE.

The accompanying illustration represents a machine manufactured by the Bridgeport Machine Tool Works, of Bridgeport, Conn., which contains some very desirable features. It is known as their screw machine, H. The bed is 7½ feet long, and the swing 20 inches over ways, and 11½ inches over carriage. The head is back geared and has a clutch for instantly changing from belt speed to back gear without stopping. It has a three-section cone for a 4-inch belt, the largest section being 14 inches in diameter. The spindle has a hole 2⅛ inches in diameter, and each end is fitted with a chuck for hexagonal, round, or square stock.



Screw Machine "H." of The Bridgeport Machine Tool Works.

In place of the usual cutting-off block, the lathe carriage has reversible cross and lateral feeds, and three tool posts. The turret is hexagonal in form and is 12 inches in diameter, with six 2½ inch holes. It has an automatic feed, and a device for unlocking and revolving at any point between 6 and 14 inches.

In addition to the regular screws, studs and bolts, this machine is very desirable where it is necessary to make a number of duplicate pieces, as special tools may be fitted, producing work at a great saving of expense.

The machine, complete, weighs 4,400 pounds.

SUCCESSFUL RUNNING OF EDCO STORAGE BATTERY CARS IN WASHINGTON, D. C.

The two Edco storage battery cars installed upon the Eckington and Soldiers Home Railway Co.'s track in Washington, D. C., March 13th, 1891, have, we are informed, given excellent satisfaction. On Sunday, April 19th, the two cars carried 1,293 registered passengers, besides nearly as many transfers, the cars running on the G. and Fifth street branch connecting with the main line of the Eckington road on New York avenue, where the trolley system is used. A fair calculation would therefore give 2,500 passengers as having been carried by the two Edco cars on that date, the greatest number registered on a single half trip being 75 passengers on the No. 1 car.

WOODHOUSE AND RAWSON, UNITED, LIMITED, ENLARGING THEIR WORKS.

In view of the large number of orders in hand for steam and electric launches, tugs, etc., together with others promised and in course of negotiation, Messrs. Woodhouse & Rawson, United, Limited, have resolved to extend their riverside premises, and have, therefore, purchased a piece of ground close to Kew railway bridge on the Surrey side, with a frontage on the river of between 600 and 700 feet, the total area being about 2½ acres.

The company will also have good dock accommodation in connection with the above, where tugs and barges can safely lie while undergoing any necessary repairs and alterations to machinery, propellers, shafting or inspection of bottoms. The new works are nearly opposite the two existing yards of the company, and will, it is expected, be in working order in the course of the next two months.

W. S. CHESLEY.

A number of recent sales are reported by Mr. W. S. Chesley, 171 Broadway, who makes a specialty of handling second hand plant and apparatus. They include two 750 light Westinghouse alternators and converters for 1,000 lights; a 10 light Weston arc machine with lamps; a 3 light American arc machine; a 50 light American; 1,200 light U. S. incandescent machine; a one h. p. motor and two ½ h. p. motors. Mr. Chesley has leased offices in the new Electrical Exchange building.

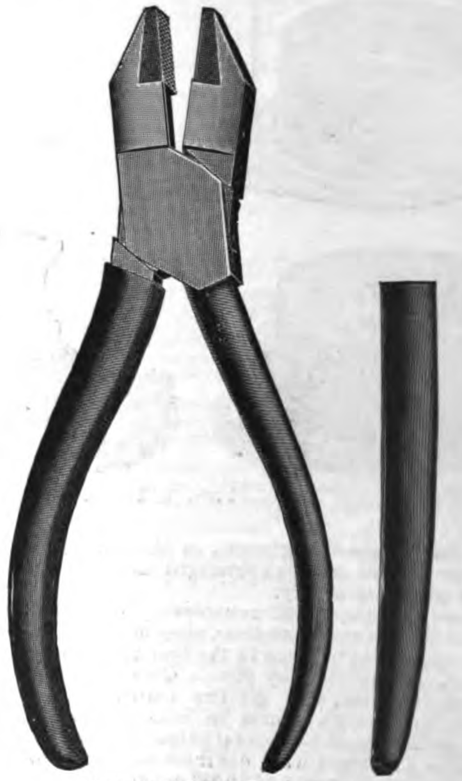
COLLECTING FARES ON THE LOUISVILLE ELECTRIC BELT LINE.

The Belt Electric Line Company has abandoned the use of bell punches on its cars. Receipts are given by the conductors for cash fares. These receipts are put up in pads, 100 to the pad. Each pad has its distinctive number and each receipt its serial number. The conductors are charged with their money receipts every night, and when they settle the next night must return the receipts in the pad, or must return cash to correspond with the missing receipts. In this way the transfer check is secured. The conductor is required to tear a receipt from the package in the presence of the passenger and is forbidden after that to allow a receipt again to come into his possession. In order that the public may be interested in receiving and taking care of these receipts, they are given a money value, that is, upon the return of 100 receipts at the office of the company the bearer will be entitled to six street car tickets. In other words, the receipts are worth 25 cents a hundred. This is certainly enough to justify people in saving them, and many small boys and girls will doubtless take an interest from this time on in collecting the receipts.

RUBBER PLIER HANDLES.

The men who work around live conductors know that the handles on their pliers ought to be insulated, and frequently resort to some crude method of supplying this protective covering. Thus they may slip a piece of soft rubber tubing over each handle or else they wrap tape around the same. Neither of these methods is satisfactory, but they show how great a need there is for some effective method of insulation.

The accompanying illustration shows a pair of ordinary pliers, protected by moulded rubber handles. These are moulded from good rubber stock, fit the handles snugly and give the hand an extra grip on the pliers. They are made to fit the various sizes of pliers used by electrical workers, and are already in use in many stations. George Cutter has the general western agency for them.



Rubber Plier Handles.

THE "A B C" FIBROUS DRY BATTERY.

Alexander, Barney & Chapin, 20 Cortlandt street, have just put on the market a new "Fibrous Dry Battery." It is reported to yield remarkable results, and Mr. Louis Walsh, of the concern's battery department, expects to do a large business with it. They have the sole selling agency for it.

Removal.—The offices of the Interior Conduit and Insulation Co., and of the Universal Arc Lamp Co. have been removed to the Edison Building, 42 and 44 Broad street, this city.

INTERIOR CONDUIT & INSULATION CO.'S TWIN CONDUCTOR.

THE Interior Conduit & Insulation Co. have issued a neat circular describing their "standard twin conductor," which we illustrate herewith. This conductor is designed to fill all the conditions of safety and reliability, particularly when employed in combination with their tubing. Beside its function as a safety conductor the following important advantages are claimed for it:

1st. It costs less money than two separately insulated wires of like quality and capacity.

2nd. It can be placed in smaller compass than any other double conductor or any two separately insulated wires, and therefore permits of the very desirable practice of placing the containing tubes on the ceiling and side wall surfaces, and then covering them with the ordinary plaster, thereby obviating the bad practice of running the tubes under the floors or behind the lath and plaster or of cutting channels in fire proofing.

TWIN CONDUCTOR.

3d. Its extreme flexibility renders it easy to draw in and out of tubing of very close approximation to its own diameter.

4th. The combination of the two conductors in one tube and in one strand, materially lessons not only the cost of material but of the labor in any given installation.

5th. It affords an absolute guarantee that any fault that may develop at any time will result in a short circuit, and therefore blow the safety fuse and thus remove all danger.

ARNY BELTING IN THE EDISON STATION AT PHILADELPHIA.

The immense plant of the Edison Electric Light Co., in Philadelphia, which, when completed, is to contain an aggregate of ten thousand horse-power, has adoped after a competitive trial of six months of actual service with four different makes of belting, the Peerless leather belt of C. W. Arny & Son, Philadelphia, as being best adapted for its severe service, and this firm now have a full dozen of their Peerless belts each 20″ wide, double, in daily operation. This service is particularly severe because the necessity of economizing space has led the company to use the narrowest belt possible to do its work, and because the pulling side of the belt is nearly a vertical line, the dynamo being situated directly over the engines and the tendency of the belt being to drop away from the bottom pulley with the slightest stretch. The construction of the Peerless belt reduces the matter of stretch to a minimum, so that there has been no trouble on that point, and though some of these belts have traveled nearly a mile a minute for from twelve to twenty-four hours per day for two years, there is no wear perceptible. Indicator tests show that a pair of these belts has transmitted as high as 462 h. p. without slipping, which in view of the very unfavorable conditions is remarkable, but attributable to the special transmitting surface peculiar to the Peerless belt.

FUNK & WAGNALL'S STANDARD DICTIONARY.

Mr. Robert Grimshaw, General Editor of the Trades Department of Funk & Wagnall's Standard Dictionary, being desirous of making as complete as possible his list of mechanical and industrial terms, requests manufacturers of machinery and tools having important parts not found on those of other makers, or the names of which are not yet in general use, to send the name, definition and use of each such part to him at 115 Bible House, New York City.

PARTRICK & CARTER CO.

John R. Galloway, electrical contractor, of Washington, D. C., has just closed a contract with the new Chamberlain Hotel at Old Point Comfort, for the installation of a complete system of guest call and fire alarm annunciators. The system to be used is that of Partrick & Carter Co., of Philadelphia, and will comprise a 600 number annunciator with return board and 600 combination bells.

"A POPULAR PUBLICATION."

THE ELECTRICAL ENGINEER, is undoubtedly a popular publication with the trade and persons interested in the development and progress of electrical inventions; its descriptions of new apparatus, and the illustrations of the same are very satisfactory.—*The Phonogram.*

CENTRAL STATION BLANKS.

IN reply to inquiries as to the forms and blanks for central station use, now being shown in Mr. H. A. Foster's copyrighted series of articles on "Central Station Management and Finance," we would state that arrangements for printing and selling these blanks have been made by the printer to THE ELECTRICAL ENGINEER, Mr. C. C. Shelley, 10 and 12 College place, this city. All orders for these blanks or inquiries as to price, should be addressed to him, and will receive prompt attention. The blanks, which are shown in reduced fac simile in the articles, are of good, ample size, and are well printed by him on good paper. Their cost is small and they will pay for themselves many times over in any station conducted with their help. Mr. Shelley has been the printer to THE ELECTRICAL ENGINEER for nearly ten years, and may be depended upon for prompt and satisfactory execution of any orders.

347 "THE ROOKERY."

The Western office of THE ELECTRICAL ENGINEER will henceforth be located in more commodious and sumptuous quarters at 347 "The Rookery," This step has become an imperative necessity owing to the growth of the paper and the numerous callers and electrical visitors to Chicago, who desire to drop in at THE ENGINEER'S headquarters in the West. The office will be found open at all times. Mr. W. Forman Collins will be delighted to see his friends and all the electrical fraternity there, and have them write as many full page articles for the advertising colums as they wish.

POLYCHROME FINISH ON TIN GOODS.

The Consolidated Fruit Jar Co., of 49 Warren street, this city, have long been known for the variety and excellence of their general sheet metal goods, and especially their products in the electrical line. They are now inviting attention to a novelty which they have worked out after considerable experiment. This novelty is in the shape of perfected lacquers, to produce a polychrome finish on ordinary tin goods. It will bear considerable ornamentation, and has a novel, pleasing appearance. The sample sent us suggests that many of our manufacturing readers putting up goods in tin packages might find it worth while to correspond with the company. Mr. A. L. Fisher is the secretary.

THE EDISON PLANT IN TORONTO.

A large number of leading citizens inspected recently the fine Edison Station in Toronto. Under the guidance of Messrs. Fred. Nicholls, manager; W. E. Davis, superintendent, and A. E. Anderson, assistant superintendent, the visitors were piloted through the premises and examined the many intricate and interesting features of the machinery. In the basement are eight Edison dynamos, six of 1,000 sixteen candle power lights and two of 2,000 lights, these latter being the largest in the Dominion. These supply seventeen miles of underground wires already in operation, and arrangements are completed for laying ten additional miles this summer. Two Armington & Sims high speed engines, one of 175 horse-power and one of 300 horse-power, and two Straight Line engines of 175 horse-power run the dynamos, each of these giving 260 revolutions per minute. In the boiler room are seven return tubular boilers of 125 h. p. each, built by the John Doty Engine Company of Toronto. The buildings are at present only partially completed, but when finished will be a handsome block of five stories and basement, in red brick with stone facings.

AT THE JAMAICA, W. I., EXHIBITION.

A very interesting exhibit of telegraphic apparatus has been made at the Jamaica exhibition, Kingston, Jamaica, West Indies, by Mr. H. C. Wilson, the efficient superintendent of Government Telegraphs. Mr. Wilson showed not only a variety of modern apparatus, but a number of relics. The electric lighting of the exhibition has also been quite extensive and successful.

ELECTRICAL SLATE.

Frederick Robinson, of Fair Haven, Vt., makes a specialty of supplying slate for electrical purposes, for the bases of switch boards and other apparatus. Mr. Robinson undertakes to supply slate that is free from iron or other conducting substances, and meets with such a demand from the electrical trade that he has been obliged to put up special machinery for the manufacture of bases in shapes and sizes, drilled, polished or marbleized, to keep up with his orders. Mr. Joseph Joutras is the selling agent for Mr. Robinson's electrical slate.

NEW YORK TRADE NOTES.

The Field Engineering Co. have removed to their new offices, 618, 619 and 620 Central Building, Liberty and West streets, where, with increased facilities, Mr. C. J. Field and his associates will handle their large and growing business.

Charles A. Schieren & Co., 45–51 Ferry street, this city, have been receiving numerous orders for perforated belting for electric street railways. Among them are the Brooklyn City R. R. Co., Brooklyn, N. Y.; Citizens' Electric Railway Co., Green Bay, Wis., and many others. Their perforated belting is found to be especially adapted to the uneven strain of street railway work. The different agencies of this firm at Chicago, Boston and Philadelphia, report business as booming in their different territories.

L. A. Fahr, who recently severed his connection with the United Electric Light and Power Co., has established himself at 415 Washington street, Hoboken, N. J., as electrical and mechanical engineer. He will deal in all kinds of electrical supplies and specialties, and also take 'contracts to construct private, isolated and municipal electric light stations for any system.

The Electric Construction & Supply Co. report, among the numerous sales for last week, 38 arc lamps of their regular type for the New York ferry house of the Central Railroad of New Jersey. The current for these lamps is to be supplied from the plant in this company's new building, corner Liberty and West streets, the cables to be run underground across West street. They also have contracted to install 185 of these lamps in the large store of The H. B. Claflin Co., this city. This makes the largest low tension arc installation up to this time.

The Crescent Insulated Wire Co., of Trenton, N. J., have nearly completed their factory. The machinery is now being placed in position and they will be manufacturing wire in about ten days.

WESTERN TRADE NOTES.

The Shultz Belting Co., of St. Louis, have just closed a contract with the St. Louis & Suburban R. R. Co. for two 72 inch belts each 154 feet long. Also ten belts 16 inches wide aggregating 700 feet. All belts to be double leather and cemented only, no rivets or pegs to be used.

Mr. Geo. T. Manson, of Okonite, spent a few days in Chicago last week, and called at the western office of The Electrical Engineer.

World's Fair Progress.—Work on the electrical departments of the Columbian Exposition is being vigorously pushed forward and every effort made to give the best facilites to the exhibitors of electrical machinery and apparatus. Already more than 100,000 square feet of space have been applied for and everything points to the fact that this will be largely increased within the near future. Prof. Barrett is handling the situation in a masterly manner and will put in a determined demand for everthing that the electrical people require to make an exhibit of unparalleled diversity and extent; and he will assuredly obtain every facility that he needs to this end. Something like 4,000 h. p. is at present called for partly in steam power for operating dynamos etc., and partly in the form of electrical energy for many different uses. This is, however, still a relatively insignificant figure.

Mr. E. W. Bennett, assistant manager of the Western Electric Co., left Chicago last week on an extended western trip to the coast in the interests of the company. The orders are already beginning to pour in and probably will continue to do so.

The Central Electric Company.—In future the important and varied announcements of the above company will be found displayed in generous Western full page style, in hues of black and orange, upon the inside page of the back cover of The Electrical Engineer, and week by week something new of absorbing interest to electrical people will be found there, telling of a place where they can obtain anything from a push button up to Okonite products by the car load, or "Packard" lamps by the ship load.

The Chicago Electrical Mfg. Co., are very busy on experimental and general electrical work. They are making quite a number of novel and valuable electrical specialties in the form of switches, rheostats, &c. They increased their manufacturing plant, recently, and now occupy the whole of the second floor at 73 W. Jackson street. Mr. J. D. Claghorne is the manager and Mr. C. P. Osborn, superintendent.

Mr. W. L. Adams, electrical engineer of the Northern Engineering Co., of Buffalo, N. Y., made a short stay in Chicago on his way to Marion, Ind., where he is building the new electrical railway plant of The Queen City Street Railway Co., there which comprises 6½ miles of road. Mr. Adams is the superintendent of this road.

Mr. Jas. A. Lounsbury, the electrician of the Thwing Electric Co., Lake and Peoria streets, Chicago, has recently built some highly efficient converters which have been felicitously named "The Porcupine," as they are a modified form of Mr. James Swinburne's "hedgehog" transformers. They are giving highly satisfactory results.

Mr. H. M. Underwood, the Western agent of the Interior Conduit and Insulation Co., recently made a short trip to Milwaukee, where his system received the usual hearty endorsement. Mr. Underwood reports the outlook for business in the Northwest as exceedingly encouraging.

Mr. Geo. A. Searing, the Western representative of the National Electrical Manufacturing Co., of New York, has just returned from a highly successful business trip to St. Louis.

Mr. Wm. Hood, the Western agent of the Accumulator Company and Electro Dynamic Cos., of Philadelphia, has largely increased his facilities at 239 La Salle street, where he now occupies the entire store. He will carry a large line of the above companies' goods and a complete outfit of adjuncts to their systems, as well as general supplies of high merit for lighting and power work. Mr. Hood, with his new facilities, will do a largely increased business.

The North American Electric Co., are selling a very large number of the "Gladiator" dry batteries which they manufacture. They will also place a new arc lamp for incandescent circuits on the market very shortly, together with a number of other good things electrical.

Mr. J. W. Hoffmann, electrician of Pullman, was a caller at this office last week. He is very busy wiring up cars for lighting and bells and making the various small parts used in this work.

Mr. H. F. Probert, M. E., for several years associated with the Sheffield Velocipede Car Company, of Three Rivers, Mich., manufacturers of railway specialties, has now connected himself with Fairbanks, Morse & Co., as their mechanical engineer.

Mr. C. A. Daigh, of the Electrical Engineering and Supply Co., of St. Paul, was a visitor to Chicago last week.

NEW ENGLAND TRADE NOTES.

The Russell Electric Co., of Boston, manufacturers of the new Russell disc carbon arc lamp, entertained a large party of ladies and gentlemen at their factory at Ballardvale, Mass., on Monday the 21st inst. The visitors about 70 in number were met at the Boston and Maine depot, by Mr. Albert W. Rounds, president, and Mr. Fred H. Carpenter, treasurer of the company, who conducted them to a special car in waiting. Mr. Edwin C. Russell, the inventor of the lamp, Mr. H. E. Chapman, vice-president of the company and manager of the factory, and Mr. Hector Denver, electrician, met the party at Ballardvale and assisted showing the visitors over the factory and explaining the merits of the lamp and the process of manufacture. The factory is now in complete running order and is well equipped to turn out large numbers of lamps weekly. At present there are about 500 lamps in process of construction, and the company have orders in hand for about 1,000 lamps. In the testing room there were displayed 25 lamps taking 9.6 amperes and about 46 volts, run by a 25-light Schuyler dynamo. The visitors expressed great satisfaction at the progress made by the company, and after a light lunch, returned to the city by the 1.25 express.

The Jewell Belting Co., of Hartford, Conn., are at present making a 36″ double belt for the Colorado Springs Electric Company, Colorado Springs, Col.; a 48″ double belt for the Omaha Electric Light Company, Omaha, Neb.; two 40″ double belts for the Johnston City Electric Light and Power Company, Johnston City, Tenn.; and a 40 inch double belt for the Connecticut Electric Company, Waterbury, Conn. The demand for a good belt for electric work is more active than ever, and the Jewell Belting Company, are gaining a wide reputation for using the very best material for dynamo belts.

Standard Electric Company of Vermont, have closed their office at 161 Franklin street, Boston, and will hereafter transact all their business from St. Johnsburg, Vt., where their factory is situated.

Mr. O. S. Platt, 88 to 102 Cannon street, Bridgeport, Conn., has issued a very neat and tasteful little pamphlet on his New England switch, illustrated and described some time ago in The Electrical Engineer. In sizes from 10 to 50 amperes, inclusive, it is mounted on porcelain bases, and from 75 to 100 amperes on slate bases.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. MAY 6, 1891. No. 157.

EXPERIMENTS ON THE RATIO OF ELECTROSTATIC TO ELECTROMAGNETIC INDUCTIVE DISTURBANCE BETWEEN NEIGHBORING TELEPHONE CIRCUITS.—I.

BY

A. E. Kennelly

THE following experiments were made with the object of not only verifying the experimental results obtained by Mr. J. J. Carty, as stated in his recent interesting paper on "Inductive Disturbances in Telephone Circuits"[1] read before the American Institute of Electrical Engineers, but also to check within fair quantitative limits the deductions from these results by reference to theory. It would seem that both these aims have been reasonably fulfilled.

Three hundred and five metres (1000 feet) of double conductor gutta-percha cable, shown full size in the diagram, Fig. 1, were laid out on the ground in a figure roughly representing a complete rectangle of sides 30 and 120 metres in length. The cable thus afforded two complete and independent circuits by the interior and exterior copper strands. The insulation between these was 20,000 megohms at the end of one minute, and their mutual electrostatic capacity 0.075 microfarad, from measurements taken at the time. The insulation of the outer strand to ground was about 4,000 megohms.

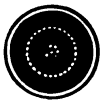


FIG. 1.

The following data give the dimensions of the cable employed :—

	Inner Strand.	
7 copper wires each	0.025″ = 0.064	cm. diam.
Strand diameter	0.102″ = 0.259	"
Diameter G. P. core	0.175″ = 0.445	"
	Outer Strand.	
18 copper wires each	0.036″ = 0.091	"
Strand diameter	0.247″ = 0.627	"
Diameter G. P. core	0.370″ = 0.940	"
Diameter over braiding	0.425″ = 1.08	"

Conductor resistance of inner strand 2.42 ω at temp. of test (12° C).
" " " outer " 0.5 ω " " "

The interior conductor was used as the primary or inducing circuit, and the exterior conductor as the secondary or recipient circuit.

The transmitter or source of disturbance was a continuous current dynamo giving 125 volts at its terminals (shunt wound), supplying about 50 amperes to incandescent lamps, and with one side grounded. A simple harmonic variation of electromotive force would, of course, be preferable for quantitative measurements, but there is some experimental difficulty in creating such a variation having the necessary frequency, while if the pure sine wave of disturbance is relinquished, and the exact shape of the wave is neglected, a dynamo becomes a very convenient transmitter. The small fluctuations in its E. M. F. produced by the successive reversal towards the external circuit of each armature coil as it passes under the brushes, are periodic variations whose frequency will be equal to the number of bars passing under each brush per second, and conversely it is only necessary to join a telephone across the mains of a continuous current circuit (through protecting resistance of say 10,000 ohms), to hear a note in the telephone whose frequency corresponds to the number of commutator bars passed over in one second by one brush. A trained musical ear will often identify this note, and thus the frequency, very closely, and the principle may be practically useful for distinguishing circuits operating at the same continuous pressure, but served by generators of different type, or to ascertain the speed of a dynamo armature when the number of its commutator bars is known. In this instance the telephone note was identified by the use of Helmholtz resonators as nearest to e''' of 1303 complete periods per second. By measuring the revolution speed of the armature, the number of bars passing under the brush per second was 1257. This number was therefore taken as the frequency of the periodic disturbance in these experiments.

Various combinations of the two cable circuits were tried so as to obtain electrostatic induction only, electromagnetic induction only, or both together. Of these the two most important cases bearing on the question are shown in the accompanying diagrams. Fig. 2, shows the arrangement of circuits in which electrostatic induction is almost wholly active, and Fig. 3, the case in which electrostatic induction is negligible, electromagnetic induction being displayed to full advantage.

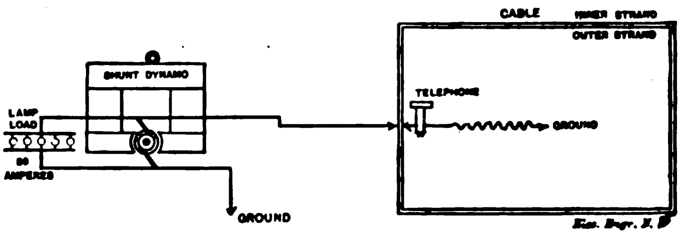


FIG. 2.

Referring to Fig. 2, the dynamo is connected directly to the interior conductor, while the exterior is connected to ground through a Bell telephone having a resistance of 73 ohms and an inductance of 113 *h*. The dynamo note was heard in this telephone. The effect was not due to leakage because a battery of fifty volts replacing the dynamo, and working through an interruptor, produced no sound. The disturbance was therefore accepted as wholly electrostatic. It required a very large resistance in circuit between the telephone and ground to bring the note down to the limit of audibility. With resistances of graphite, the amount needed to reach this limit was found to lie between 2 megohms and 10 megohms. It was estimated at 7 megohms.

In Fig. 3, the dynamo is shown connected through a galvanometer and bank of lamps to the interior conductor of the cable, the other end of which is grounded. The only appreciable inductance in this primary circuit is in the dynamo armature. Inductance is capable of being inserted between the galvanometer and lamps at will. The outside conductor completes its own circuit insulated from the ground through the telephone and resistance. Corresponding to different strengths of current in the primary circuit, resistance is added in the secondary circuit to bring the sound in the telephone down to the limit of audibility.

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[1] THE ELECTRICAL ENGINEER, March 25, 1891.

The results are given in the following table.

1 Current in primary circuit (amperes).	2 Resistance in primary circuit (ohms).	3 Inductance added to primary circuit (millihenrys).	4 Impedance in primary circuit (ohms ω_1).	5 Resistance in secondary circuit (ohms).	6 Inductance in secondary c'r't (millih'rys).	7 Impedance in secondary c'r't (ohms ω_2).	8 $\omega_1\ \omega_2$
0.522	239.7	—	240	80,000	113	80,000	1.92×10^7
0.740	169	—	169	110,000	—	110,000	1.86×10^7
1.419	88	—	88	200,000	—	200,000	1.76×10^7
2.608	47 9	—	47.9	400,000	—	400,000	1.92×10^7
2.774	45.1	4.96	59.7	110,000	—	110,000	6.57×10^6
2.868	43.6	37.9	302.5	20,000	—	20.000	6.05×10^6
2.608	47.9	0	47.9	400,000	—	400.000	1.92×10^7

The first column gives the observed steady currents in the primary circuit, from which since the pressure was 125 volts, the resistances in the second column are found. The third column gives the inductance (in coreless coils of copper wire) added to the primary circuit, and from these with a frequency of 1257 periods, the impedance inserted in the primary circuit to the variations of its E. M. F. are given in column 4 In column 5, appears the resistance added to the secondary circuit in order to quench the dynamo note in the telephone, and since the only appreciable inductance in the secondary circuit was that of the telephone, negligible in series with the large resistances, the impedances of column 7 are only repetitions of those resistances.

The last column gives the product of the primary and secondary impedances. This value is nearly uniform except for the cases in which inductance is added to the primary circuit. The marked discrepancy in these two cases is perhaps due to the shunting action of the load circuit supplied by the dynamo, which, being nearly inductanceless, would reduce the periodic current in the primary circuit below the calculated amount, in about the ratio here represented. For the same reason the inductance of the dynamo armature (about 0.3 *h*) has not been taken into account.

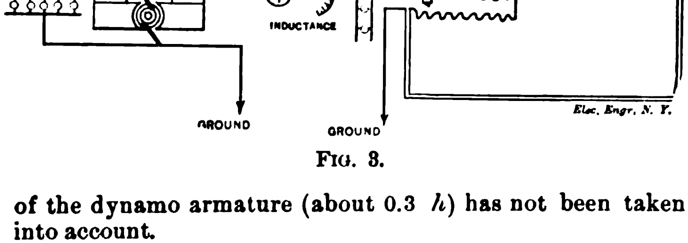


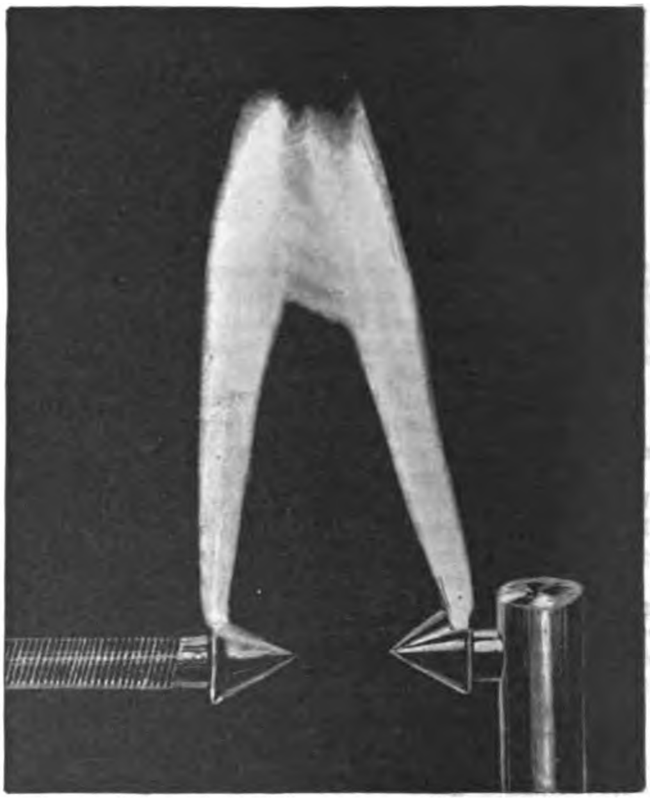
FIG. 3.

It appears however probable from an inspection of the results, that with a resistance of seven megohms in the secondary circuit, it would be necessary to reduce the primary circuit resistance to about 3 ohms in order to just render the dynamo note audible in the telephone.

The dynamo in these experiments was at a distance of about 250 feet from the telephone, and silence was obtained in every experiment as soon as the wires leading to the dynamo were disconnected from the primary circuit.

EXPERIMENTS WITH HIGH TENSION ALTERNATING CURRENTS.

MESSRS. SIEMENS & HALSKE, of Berlin, recently invited the members of the Elektrotechnische Verein of that city to their works to witness the demonstration of a series of experiments on alternating currents under a pressure of 20,000 volts. In order to show that the desired pressure was really *en evidence*, the high tension was conducted through a pair of wires of only 0·2 mm. diameter to a battery of 200 100-volt incandescent lamps, all connected up in series. An ordinary Siemens electric light cable was inserted, and broke down at a pressure of some 15,000 volts.



A 20,000 VOLT ALTERNATING ARC—(HALF SIZE).

At the end of the meeting a few experiments on the formation of the arc under this enormous pressure were shown. The sparking distance varied considerably according to the shape of the electrodes. At 20,000 volts a spark jumped from a ball to a ball about 10 millimetres, while between two points a sparking distance of 30 millimetres, and sometimes even more, was reached. This arc is shown half size in the accompanying engraving.

The arc which followed the jumping over of a spark made a loud humming and clapping noise, and flapped about, being easily carried away by the slightest draught. The arc could be drawn out horizontally to something like 100 millimetres distance between the electrodes, and even to a distance of 150 millimetres, when carbon pencils were used as electrodes, but it always remained standing up in a point.

A NOVEL GLASS POLISHING TABLE.

The Pittsburg Plate Glass Co., of Ford City, Penn., is adopting the use of electric motors in its large plant in that city. The company has a glass polishing table, which is said to be quite novel and economical in comparison with similar machines. These tables are over 30 feet in diameter and are revolved by gears which have heretofore been operated by steam. To run these tables a 100 h. p. motor is attached to a shaft which operates the gears. The Thomson-Houston Motor Co. has installed this first motor, which, though virtually on trial, is claimed to work very well.

ELECTRICAL STUDIES AT THE PRATT INSTITUTE, BROOKLYN.

BY

Alfred P. Boughton

N the 19th of May, 1887, a charter was granted whereby the organization of the Pratt Institute was completed. The Institute buildings cover an area of over 32,000 square feet, located in the block bounded on the north and south respectively by Willoughby avenue and DeKalb avenue, and extending through from Ryerson st. to Grand ave., Brooklyn, N.Y.

The work of the Institute deals mainly with special classes in the varied field of art, science, trade and technical instruction. Among these latter is a course in electrical construction.

The class in electricity begins with the first principles of magnetism, and in the laboratory the first work is with the torsion balance, with which the students experiment to show the law of inverse squares. The subject of magnetism is taken up very thoroughly. Bar magnets and iron filings are provided in the second laboratory experiment, and the students, of whom the writer has been one, are required to sketch in their note books the position taken by the filings, with the magnets in various positions. As will be seen in the engraving, Fig. 1, each pupil is provided with two cells of gravity battery beneath his desk; solenoids are made and soft iron bars provided for cores in order that the magnetic effects of the electro-magnet may be noted, and the students also learn of the magnetism caused by a current flowing in a straight wire. The next experiment has been that of the torsion balance with the electro-magnet, showing the effect on the instrument to be stronger than with the bar magnet, and also showing the varied result by decreasing or increasing the number of turns of wire on the magnet, which experiment was afterwards tried with the dynamo current, incandescent lamps being wired in series and series multiple with the solenoid, the number of turns thereon being varied, dynamo current from the plant in the basement of the building, being on tap at each student's desk.

Then, in the lecture room, the formula $C = \frac{E}{R}$ being explained, the laboratory work consisted in finding that $E = CR$. This was done by each student being furnished with a galvanometer, with calibration attached, and a resistance box, measuring the E. M. F. of the batteries, the internal resistance of which was estimated; and later, using dynamo current, the resistances of incandescent lamps were shown, the E. M. F. and current being indicated by the proper instruments.

Other ways of finding resistance—by substitution and by decreasing the current—were also shown last season and worked out by the class, the finding of the internal resistance of the batteries being one of the experiments. The Wheatstone bridge was also taken up in this connection, and the principles thereof very fully explained by the instructor, several experiments being conducted in the laboratory. The fact of the resistance of wire varying inversely as the square of the diameter was treated of in the lecture room, and in the laboratory work was done in this direction to demonstrate the fact. Under the head of resistance, I might mention that the class one evening tested the resistance of several of its members, the average of the thirteen who were willing to try the experiment being 3,518.31 ohms.

Instruction was given in the lecture room concerning induction coils, and experiments were made in the laboratory with them. An evening was spent on the subject of electroplating, and the students were furnished with a copper strip, and various substances, a carbon pencil, lead, tin, etc., to be plated. This was a very successful experiment, and one of the most interesting.

The electrical class in the Pratt Institute meets twice each week for two hours, one of lecture, and the other experiment. While the above laboratory work has been going on, the instructor has lectured on primary batteries,

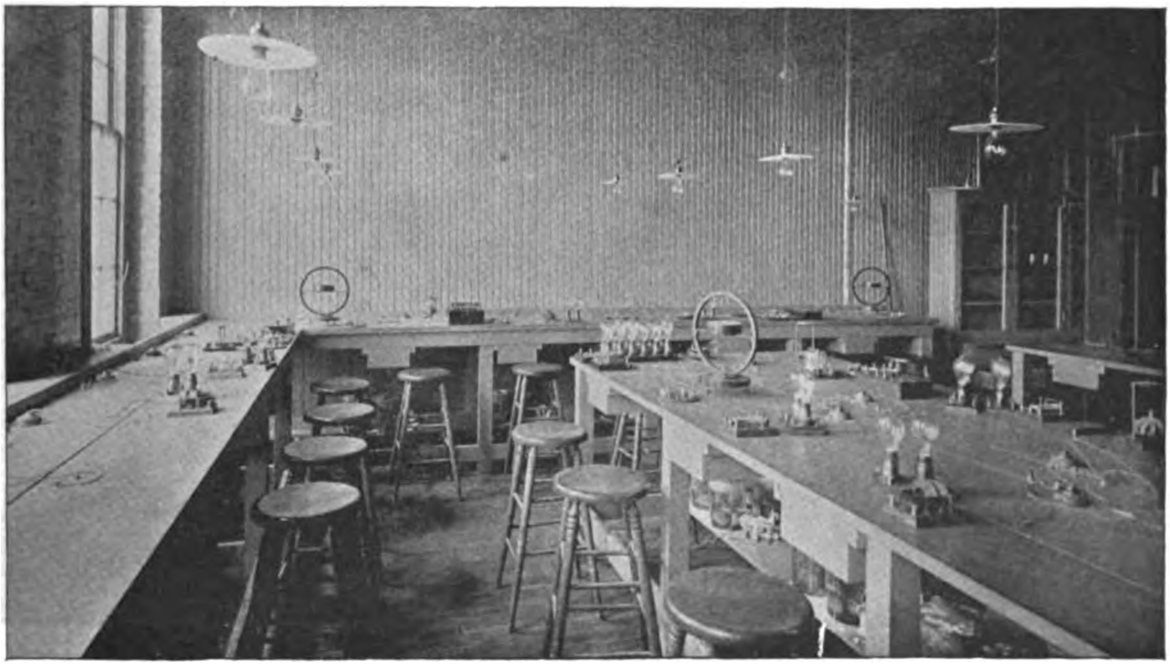


FIG. 1.—ELECTRICAL LABORATORY, PRATT INSTITUTE, BROOKLYN.

(and in this connection has given the class the E. M. F.'s of the best known makes of cells), storage batteries, telephony, telegraphy, electroplating and welding. Various laws have also been explained, a multitude of formulæ worked out, and a number of interesting tables furnished.

As will be seen by Fig. 2, there are in the laboratory a 5 h. p. Thomson-Houston motor, driven by the dynamo in the basement, an Edison incandescent dynamo capable of lighting five 110-volt lamps, and a 50-volt Westinghouse alternator, each of the latter being driven by the motor. The students are instructed as to the manner of calculating the commercial and electrical efficiencies, are shown the characteristics of the different forms of machines, and experiments are conducted to give the pupils opportunity for plotting the curves themselves, as also the curves showing variation of watts and stray power with fluctuations of speed, as well as the plotting of the curve of saturation of field magnets.

In the lecture room both arc and incandescent lighting, the two and three wire systems, were discussed, and arc lights were placed in the laboratory for the use of the class. The subjects of power transmission and street railway work were also treated of. The course was confined strictly to lectures and laboratory work, there being no text books at all, the only outside work being the necessary writing up of the students' note books for examination by the instructor.

The principle of individual laboratory work is insisted upon and the size of classes strictly limited to the capacity of the laboratory.

As will be seen, the course first treats of the scientific data of electricity and magnetism, and then traces the applications of these to the methods and constructions of actual practice.

The lecture and laboratory rooms are situated in the Mechanic Arts Building, under the supervision of Mr. C. R. Richards, while the students were under the immediate care of Mr. F. W. Dunbar, electrical engineer.

MR. BLANCHARD has resigned from the position of manager of the Norwalk, Conn., Electric Light Co.

ELECTRO-CHEMICAL EFFECTS ON MAGNETIZING IRON.

In a Paper recently read before the Royal Society, Mr. Thomas Andrews, F. R. S., gave the results of some experiments carried out by him on the effect of magnetization on the relative electro-chemical position of a pair of bright iron bars, one magnetized by a coil, the other unmagnetized, when simultaneously exposed to the action of various powerful oxidizing agents and saline solutions. He employed long polished rods of soft wrought scrap iron 0.261-in. in diameter. Each pair of pieces was adjacently cut from the same iron rod, so that they might, as near as practicable, be of identical chemical composition and molecular constitution. The pieces were placed in the legs of a U tube containing the electrolyte, every care being taken to check any E. M. F. which might occur owing to the rise of temperature in one leg caused by the current in the magnetizing coil. The solutions employed were potassium chlorate + one-fifth and one-third nitric acid, potassium chlorate and hydrochloric acid, 25 per cent. and 20 per cent. aqueous solution of nitric acid, a 50 per cent. aqueous solution of hydrochloric acid, concentrated sulphuric acid (Sp. gr. 1.84). The magneto-chemical effects were very small, being usually of the order of 1×10^{-3} volt. The magnetized rod was in every instance, except when dilute hydrochloric and concentrated sulphuric acid were employed, the positive element. In the exceptional instances alluded to, the electro-negative effect occurs, possibly owing to the presence in the solution of such reducing agents as nascent hydrogen.

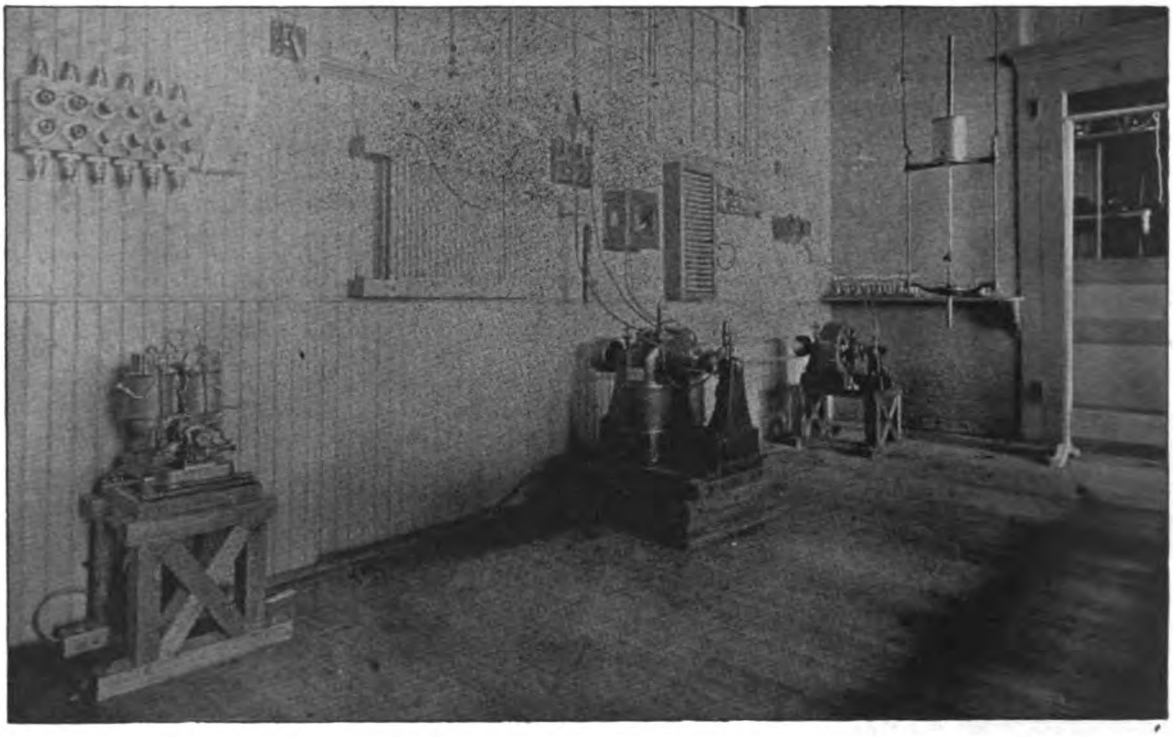


FIG. 2.—ELECTRICAL LABORATORY, PRATT INSTITUTE, BROOKLYN.

PROF. THOMSON'S WATCH CHAIN.

Prof. Elihu Thomson wears a unique watch chain, the links of which are welded by electricity. In part of the chain, links of gold and platinum alternate. Other links are made of sections of these metals.

MR. HENRY GRAY has been promoted to the position of assistant superintendent of the Edison Electric Light Co., of Paterson, N. J.

CENTRAL STATION MANAGEMENT AND FINANCE.—III.

BY

Horatio A. Foster

Electrical Department.

The reports and records for this department are necessarily more in number and worked out in greater detail than those of other departments. The blanks required are as follows:

No.	3.	Report of Circuit Tests.'
"	4.	Inspector's Report.
"	4A.	Complaint Card.
"	6.	Dynamo Engineer's Report.
"	6A.	" " " (small).
"	7.	'Daily Lamp Record.
"	7A.	Arc Switchboard.
"	8.	Ampere Report.

Jointly with the Supt. of Construction the Circuit Register blank, No. 3, is used.

[Form 3.] Copyrighted [illegible]

______________________ Company.

______________________ 189

Report of Circuit Tests.

All Circuits not mentioned below are in every way **O. K.**

TIME.	CONDITION AND TIME TROUBLE REMOVED.

REMARKS.

State condition of weather at each time of test.

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Signed, ______________________ *Inspector.*

Blank No. 3.—Report of Circuit Tests.

The dynamo engineer is the executive officer of the dynamo and lamp departments and under the supervision of the electrician, who, by the way, is usually the superintendent. The dynamo engineer has charge of the switchboards, dynamos, lamps, and in fact all electrical machinery and repairs on the same.

He must see that the circuits are in proper condition to run as tested from the switchboard, and by this we mean chiefly the arc circuits, as incandescent and some power circuits are run all the time, and can have only such tests as are made by ground lamps and detectors, of which there are many very good ones to be had.

Arc circuits, when not in use, are tested three or more times per day for continuity and grounds, and if found in any way defective, are immediately reported to the superintendent, who sends some one to hunt up the faults. At present such testing is done with the ordinary magneto-bell, but the galvanometer is coming more into use, as the managers become acquainted with it. Soon we hope to make and use blanks which shall record the insulation of all lines. After starting, the circuits should be tested every hour with ground wire through high resistance, say a bank of incandescent lamps. Mr. M. D. Law, formerly of Philadelphia, made a very ingenious use of the lamp-bank. His lamps, for full c. p., required about 50 volts. He placed a number in series with a voltmeter across the terminals of one of them, to indicate when full potential or c. p. was reached. Then by turning off lamps until a number showed full potential, he could tell by that number about where his ground was located on that particular circuit.

[Form 4.] Copyrighted [illegible]

______________________ Company.

______________________ 189

Report of Inspector No. ______

from ______ *o'clock,* ___ *M., to* ______ *o'clock,* ___ *M.*

Weather at Midnight ______________________

LIGHTS OUT OF ORDER.

LOCATION OF LAMPS OR NAME OF CUSTOMER.	TIME Reported Out.	TIME O. K.	TOTAL TIME Out of Order.	CAUSE.

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Signed, ______________________ *Inspector.*

Blank No. 4.—Inspector's Report.

As in all well-regulated stations, there is generally serious trouble on only a few circuits, it is thought unnecessary to make mention of circuits other than those which have faults. Therefore we think form No. 3 herewith covers the ground.

The condition of the weather cannot be stated at too many parts of the day, hence the number of reports having a line for that condition.

Inspector's report, form No. 4, is used by night circuit inspectors, and in fact by any one who has a statement to make in regard to the condition of circuits or apparatus. For instance, trimmers report lamps out of condition, globes broken or other faults. Inspectors report lamps out, with the cause and the time out. This is recorded the next day on the lighting register, and if confirmed by the trimmer's report or book, is deducted as rebate from the customer's bill. Incandescent or motor inspector's report refers to switches, fuses, cut-outs, lamps renewed, etc.

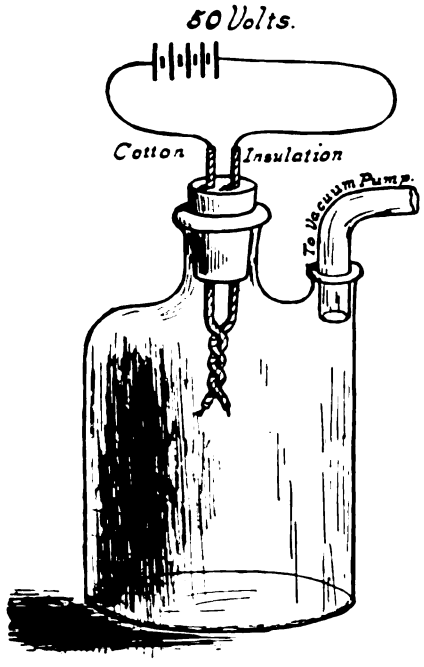
OIL AS AN INSULATOR FOR HIGH POTENTIALS.—II.

BY

David Brooks

The accompanying diagram represents a semi-exhausted chamber into which two cotton-covered wires are introduced, and between which a disruptive discharge is produced with a current of fifty volts; and, after once started, this arc is maintained with a current of two volts or two Daniell cells. The illustration is nothing more than what is shown by a Geissler tube.

Now, in the insulation of conductors that are coiled and uncoiled, air spaces are liable to be formed. The insulation is thereby rendered non-homogeneous, and currents of high potential are liable to break through and produce what is sometimes called disruption. This feature in underground subways is the source of much expense and annoyance. If you go into the yards of the different electric light companies in the city of New York, you will find tons of cable that have been disrupted and rendered useless from this one cause.



Experiment With Disruptive Discharge in Semi-Vacuum.

It is also the cause of the many explosions that have occurred in the subways of New York, and to prevent these explosions there is now employed a large force opening the manholes and ventilating the subways by the use of rotary fans, and other means. In New York, if the ducts are tolerably clear of gas, no explosion occurs where the conductors are encased in lead pipe. The conductors are drawn out after becoming useless and put away among the scraps of the yard, or sent to the factory again where they are stripped of the lead and re-covered.

In Philadelphia the subways are made of wood, and disruption not only produces explosions, but often sets fire to the wood of the subway. It is not two weeks since a fire of that nature occurred between Seventh and Eighth streets in Chestnut street, and a gang of men were employed for eight days putting in a new subway and replacing the burnt portions of the cable. These wooden subways are used to a considerable extent by the Edison Company, not from choice but from necessity, and the superintendent states that they have a break-down or a fire as often as once per day.

In the foregoing article I explained how much easier it is to spark through natural air and a semi-vacuum than through oil. Wires, covered with cotton one-sixteenth of an inch and, say, one-eighth of an inch apart in oil, will withstand an electromotive force that sparks four inches through the air. Roughly, it takes thirty-two times the potential to spark through oil that it does through air; hence, the great advantage of having a conveter immersed in oil as compared to one not in that condition, or used in the ordinary manner.

Very many converters are injured by lightning; but electric light conductors are not nearly so much exposed to atmospheric influences as telegraph conductors; yet they are much more liable to injury, from the fact that an atmospheric impulse may produce a spark that would not injure a relay, being no more than is often used upon an electric gas-lighting burner; but this miniature spark when once produced, is followed by a current of thousands of times more amperage, that produces the mischief.

All these objections to the use of subways or ducts are avoided by the use of oil, and when it comes to converters used in connection with overhead conductors, the chances of interruption by atmospheric discharges are immensely reduced.

It is often said that in the subway system you can pull out the conductors, and draw in others. With the oil system, up to this date, there has never been an occasion to require the conductors to be drawn out. But if there were occasion, a thousand feet could be drawn out easier than two hundred and fifty feet in any subway system.

Bearing in mind that an electric light conductor, of whatever size one may choose, costs from four to six times as much when drawn into a subway as when insulated with oil, and all other conductors in the same proportion, and remembering also the cost of the subway as compared with the single oil pipe, then the cost of the oil system as compared with the subway system, is less than the proportion of one to ten.

THE SING SING EXECUTION PLANT.

Warden Brush, of the State Prison, who retires from his position on May 1st, will leave behind him an execution plant that he believes to be perfect in its way. He has built a small wing to the building in which capital prisoners are confined, as an execution chamber. This wing is divided into two rooms. In the first is the death chair, which is of heavy oak, and in which the culprit can be securely strapped in less than one minute. Back of the chair is a small closet, built out from the partition. On one side of this is the switchboard, with the voltmeter, resistance box, &c. Over this are 20 incandescent lights in series, calling for 2000 volts when run at full power.

The warden, standing at the chair, can give the signal to the man at the switchboard. The pressure of the button signaling the dynamo room will bring the full current to the incandescent lights. None goes to the chair until the warden gives another signal, when the operator in the closet, who cannot be seen by anybody present, switches the full current from the lamps to the wires leading to the chair. The dynamo is now 1,000 feet away from the execution chamber; but it is intended to bring it up to the room adjoining that in which the chair stands, so that the whole apparatus will be in charge of men within reach of the warden's voice.

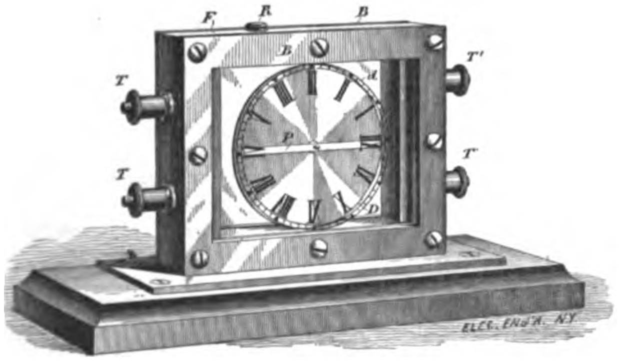
AN ELECTROLYTIC CLOCK.

BY

Nikola Tesla

If a delicately pivoted and well-balanced metal disc or cylinder be placed in a proper plating solution midway between the anode and cathode, one half of the disc becomes electro positive and the other half electro negative. Owing to this fact metal is deposited on one, and taken off from the other half, and the disc is caused to rotate under the action of gravity. As the amount of metal deposited and taken off is proportionate to the current strength, the speed of rotation, if it be small, is proportionate to the current.

The first device of this kind was operated by me early in 1888, in the endeavor to construct an electric meter. Upon learning, however, that I had been anticipated by others, as far as the principle is concerned,[1] I devised the apparatus illustrated in the accompanying engraving. Here F is a rectangular frame of hard rubber which is fastened upon a wooden base. This frame is about ½ inch thick, 6 inches long and 5 inches high. On both of its upright sides are fastened thick metal plates which serve as the electrodes. These plates are held firmly against the rubber frame by the binding posts T T and T' T.' On the lateral sides of the frame are fastened the brass plates B and B,' respectivly, of the same shape as the rubber frame F. These brass plates serve to keep in place two plates of polished glass, and the vessel is hermetically sealed by placing a soft rubber washer under and above each of the glass plates. In this manner the plates may be screwed on tight without fear of breaking them.



TESLA'S ELECTROLYTIC CLOCK.

The plating solution, which in this case is a concentrated solution of sulphate of copper, is poured in through an opening on the top of the rubber frame, which is closed by a plug R.

In the center of the vessel is placed a light and delicately balanced copper disc D, the axis of which is supported by a capillary glass tube which is fixed to one of the glass plates by means of sealing wax, or other material not attacked by the liquid. To diminish the friction as much as possible, the capillary tube which serves as a bearing contains a drop of oil. The center of the disc should be equi-distant from both the electrodes. To one side of the axis of the disc is fastened a very light indicator or pointer consisting preferably of a thin glass thread. The glass plate next to this pointer has a circle with the usual hour divisions engraved upon it, as on a clock dial. This circle may be movable so that it can be put in any position relatively to the pointer. If the dial is not movable then a thin wire of annealed iron may be used as on a pointer. The wire should then be so placed that it is exactly in the centre of the solution. By means of a horse-shoe magnet the disc may then be rotated and set in proper position.

The copper solution being carefully poured in, and the plug R replaced, the terminals of a constant current battery are connected to the binding-posts T T', and from time to time the rotation of the disc is observed. A shunt is connected to the other two binding-posts T T', and by varying the resistance of this shunt, or other disc, the speed of rotation is regulated until it is made to correspond to the division of the dial; that is, until, for instance, one turn is made in 12 hours.

Obviously this instrument was not devised for a practical purpose. Neither will it be quite exact in its indications. There are certain errors, unavoidable from the principle; for instance, the friction, which cannot be completely overcome. But the device is interesting as a means of indicating time in a novel manner. It will, however, be found that by a careful construction, constant current, and a temperature compensator, it may be made to rotate with almost perfect uniformity. The current density should, of course, be very small to secure the best results, and the disc of about 3 inches diameter should turn once in 6 hours. It is probable that with a silver solution and a silver plate better results would be obtained.

It is very interesting to note the appearance of the solution and disc in such a narrow transparent vessel. The solution appears a clear blue, one side of the disc seems to be silver white in a certain position, and the other half is dark like tarnished silver. There is no line of demarcation, but the shades melt beautifully together.

OPERATING SUB-STATIONS BY THE MOTOR-DYNAMO SYSTEM IN BROOKLYN.

BY

W. S. Barstow

THE Edison Electric Illuminating Company of Brooklyn, during the fall of 1890, resolved to extend their territory for furnishing low tension light and power, by the erection of a second district station. After a careful consideration of the matter, it was deemed best to supply this new territory from their present first district station until a sufficient load was accumulated to warrant the expenditure necessary for the erection and maintenance of the second district station. For this purpose a large feeder, consisting of copper conductors of 1,000,000 circ. mils each was laid underground to a point two miles distant from the present first district station. From this point sub-feeders were laid, and these in turn were heavily bridged by the net-work of mains. A standard feeder is selected from one of these sub-feeders, and at the extremity of this the voltage is kept at a constant pressure. As the load increases, the voltage is necessarily raised at the station end of the large feeder so as to preserve the voltage at the extremity of the sub-feeder. The efficiency of this system of low tension long distance transmission depends on the cost of the loss in the main feeder compared with the increased operating expenses of a second district station. When the cost of the loss (in watts) in this transmission equals the operating expenses of a second district plant, then this plant will be erected and will be run until the cost of operating exceeds the loss in transmitting from the first district station. It has been theoretically calculated (and since proved by practical results) that 1,000 amperes can be transmitted before the starting of the new station is necessary.

After the plans of underground feeders had been fully developed, attention was turned to the mode of generating this transmitted current. As the first district station is supplied with auxiliary busses, it was a simple matter to operate one or more station units (300 h. p. Ball compound non-condensing engine and two No. 32 Edison generators), on an auxiliary bus and connect the main feeder to it; but when it was taken into consideration that the new district load at certain portions of the day would not be more than 50 h. p. the efficiency of a large station unit became evident.

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[1] The same invention is attributed to J. T. Sprague and T. A Edison.

After due consideration it was decided to operate the generators supplying this feeder by a motor, which, in turn, would be supplied by the bus of the first district station. A 50 h. p. C. & C. motor with pulley at both ends of the armature shaft was installed and connected to the station bus, and from this were belted two No. 6 Edison compound generators. This plant shows an average commercial efficiency of over 75 per cent. while the efficiency of the large station, by reason of the extra motor load, is increased over 10 per cent. The advantage of this arrangement can be better appreciated when it is known that, on a station unit, the loss of power due to engine friction and belting on an average load of 224.9 h. p. (at the engine) is 33.5 h. p. Should the load on the engine average 50 h. p. the low efficiency of the unit can easily be appreciated. The question of installing a smaller engine was contemplated, but on close investigation the idea was abandoned in favor of the motor.

The mission of this motor-dynamo plant is nothing more than to transform the bus pressure of the first district station to a variable pressure required at the station end of the large feeder in order to maintain a constant pressure at the standard sub-feeder extremity. Should the pressure on the station end of this main feeder equal the bus pressure of the first district (on account of light load), the little motor-dynamo plant is shut down, and the feeder thrown on to the station bus. Should the load exceed the capacity of the little plant, it is then of such proportion as to render the larger station unit efficient. One favorable point in this transmission system is that no extra help is required, the men usually employed in operating the large station easily taking care of this slight increase.

Work was commenced on this system on about October 15, 1890, and before December 1 a system of mains and feeders (capacity 2,000 16 c. p. lamps) was supplying 500 16 c. p. lamps, 26 Ward low tension arc lamps and 10 h. p. in motors. On April 1, 1891, there were connected to this system 2,000 16 c. p. lamps, 58 arc lamps, and 65 h. p. in motors. The little motor-dynamo plant furnishes current from 2 a. m. to 6 p. m., a station unit from 6 p. m., to 11 p. m., and the station bus from 11 p. m. to 2 a. m. Until the evening load was sufficient to be carried on a station unit, this motor-dynamo plant was in operation 21 hours per day and seven days per week.

When the new second district station is started, the main feeder will serve as a tie line between the two stations, so that either can be shut down during a light load to save operating expenses.

Among the many consumers in this district there is one who is operating one motor of 25 h. p. and two of 10 h. p., which are supplied with current at a point two and three-quarter miles distant from the little transmitting plant.

SUING HIS RIVALS FOR SLANDER.

Jacob H. Shay, a stockholder and salesman for the Charles Munson Belting Company, began suit last week for $20,000 damages for slander, against James Moloney, president, and John M. Thomas, secretary of the Chicago Belting Company, a rival of the concern in which Shay is employed. Shay charges that the two defendants circulated a story that he (Shay) had a monopoly of the belting trade with the Thomson-Houston Electric Light Company, because he had subsidized the purchasing agent of that company, one Sunny, and had bribed the latter with $50, for which Sunny gave all the belting work to Shay. The latter declares that the charge was wholly untrue, and made to injure his reputation and trade.

REFORMS IN THE PATENT SYSTEM.

BY

Thomas Ewing, Jr.

The patent system has for many years encountered a powerful and growing opposition. A Federal Senator told the writer recently, that he was for wiping the act from the statute books. The Farmers' Alliance have demanded that the term of the monopoly be limited to ten years, and the agricultural classes generally are disposed to look upon the system as of a piece with the high tariff and the rest of that body of vast, and in their view at least, vicious class legislation which has destroyed their hopes for a generation. On no class does it bear so heavily; they are not inventors, and the rule which makes the individual user of a patented article, who has purchased it of an unauthorized seller, though in entire good faith, liable for infringement to the owner of the patent, has made them, disunited as they are, easy prey to the greed and fraud of unscrupulous patentees.

Unable to make their opposition felt at any other point, the enemies of the system have resolutely opposed, and in large measure defeated, all attempts to extend and improve the Patent Office. The work of the office is rapidly increasing in quantity, while the growth of the arts makes investigation of the individual invention more and more difficult. Against 13,947 patents issued in 1880 there were 25,321 in 1890. A discovery is announced, and, almost before the sun is set, the office is flooded with the inventions of claimants who have applied the new principle. One is reminded of the lines in Hiawatha, which describe trouble as coming like birds of prey on a carrion:—

> "First a speck and then a vulture,
> Till the air is dark with pinions."

About 900 applications for patents are filed every week. Almost all the applications, as filed, contain claims that are anticipated in the arts, and in some cases many official actions and responses by the applicant are exchanged before an agreement as to the proper scope of the invention is reached. All this large and difficult work is dispatched by a force of examiners numbering less than 200, the personnel of which is rapidly changing.

No one unacquainted with the task can form an adequate conception of the difficulty of a fairly complete search. The skillful searcher must possess the insight of an inventor, and, looking beyond the utility disclosed, discern all other uses to which the invention could be put, that he may know in what outlying classes to look for anticipating devices. Some of the rejections made by the office, though sound in principle, seem rather ludicrous; for example, an electroplater's rack, described as consisting of two resilient bars of metal joined with a spring at one end and a clasp at the other, anticipated by a common hair crimper.

Thus the Patent Office is in chronic need of increased force and, ever since the war, has needed better salaries. Here is the farmer's opportunity to wing his shaft. No increase of salaries has been allowed in 42 years, and almost every call for more men has been answered by flat refusal, or scanty allowance of the lowest grade of assistant examiners. It might be well for those who thus cripple the patent office to consider what they are really accomplishing.

A little reflection will show that, without touching a hair of the system of protection, they are merely introducing the British system of granting patents to all comers upon registration, for our system which contemplates the granting of patents only for inventions ascertained to be new and useful. But while thus approaching more and more nearly the British system, we omit its safeguards. If the British patentee claims more than he is entitled to, his patent is invalid, but under our law only the claim that is too broad falls. Multitudes of patents are issued which might easily be found to have been anticipated in whole or in part upon careful search. Once issued they become difficult to defeat. Prior use must be established beyond reasonable doubt; and suits over valuable patents are apt to be merely contests for a share of the spoils of the monopoly. In the early telephone suits the opinions of Judge Lowell in the Spencer case, and Justice Gray in the Dolbear cases both state that the defendants admitted that Bell was the first inventor of the telephone. When this statement is contrasted with the assertion in the recent authoritative work of Messrs. Preece and Maier on the telephone, that Reis's telephone constructed 15 years before Bell's, "contained the essential features of the present telephone and certainly did transmit speech," it becomes plain that the one possible defence in which the public was largely interested, viz.: the anticipation of Bell by Reis, was waived. Where plaintiff and defendant agree, the public are counted out; for, though a party in interest in every suit to enforce a patent, they are not represented. If the patent office were thoroughly organized and equipped to conduct adequate searches before patents are granted, it would be a powerful agent for the protection of the interests of the public—an agent which the British system entirely lacks.

But there are defects in the administration of the patent office which render it an inefficient guardian of the interests of the public. Anxious to escape the imputation of hostility to inventors, and constantly importuned by solicitors seeking the broadest patents which the inventions disclosed will possibly warrant, many examiners are disposed to resolve all doubts in favor of applicants for patents, since the claims allowed, if too broad, can be declared void by the courts. But, as pointed out, the public are not represented in the courts, and the office jeopardizes their interests whenever a claim is allowed which a court should not sustain.

Again, the work of the office should be more rapidly dispatched.

It may seem a hopeless task to attempt this reform, when it is recalled that the ministers of the law were distressingly behind with their work in Hamlet's time, and have not caught up yet. But the fault in this case lies with the law rather than its ministers. There are a few vicious sources of delay which can be readily removed by legislation.

Under the present law, an applicant, in prosecuting his application for a patent, must answer each requirement of the office within two years of the date thereof. This liberal allowance of time, though necessary in some cases, where the citation of analogous inventions necessitates elaborate experiment and inquiry by the applicant, is, in a great majority of cases, excessive, and particularly where the invention has been tested by extensive commercial use. When, however, the aim of the prosecutor of the application is to consume time, claims are inserted which the office must reject, and two years allowed to elapse after each official action before reply; or an interference contest, like that of Edison and Berliner, both sides of which are owned by the American Bell Telephone Co., as stated in The Electrical Engineer of April 15, is fought to the bitter end by the single party in interest.

Thus the life of an application can be extended indefinitely. But the patent, when finally issued, runs for 17 years from the day of issue.

If the time within which response to official action may be made without explanation of delay were reduced from two years to something like two months, and the statute were to declare that where it appears upon the face of the record, or is clearly established, that the life of the application has been prolonged for the sake of delay, the patent shall be refused or declared void, this abuse would, in large measure, disappear.

The extension of the Patent Office, which all who deal with it so earnestly desire, can be accomplished as the result of a compromise. If those interested in the patent system will consent to the removal of existing abuses, its enemies can hardly stand so completely in their own light as to refuse to make the office an efficient public servant. This accomplished, the system of industrial protection, which has benefited us so greatly during the past century, may continue to bless us for centuries to come.

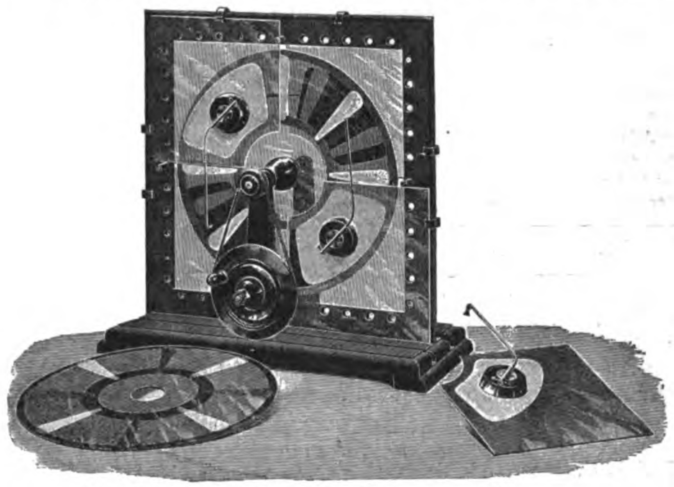
WIMSHURST'S ALTERNATING INFLUENCE MACHINE.[1]

A remarkable feature of this new machine is that while it gives an abundance of sparks, it is impossible to charge a Leyden jar, or similar contrivance, from it.

The conclusion is therefore forced upon us that the current of sparks is really the oscillation of a small charge, which flows backwards and forwards with great rapidity between the machine and the jar. The electricity that is developed is alternately positive and negative, and the normal condition of the jar is not upset.

Commencing to turn the disc exceedingly slowly, say, at the rate of three or four revolutions per minute, the leaves of the electroscope suddenly diverge, being repelled from each other. They remain apart quite steadily until the disc has made rather more than three-quarters of a revolution, when they suddenly approach and cling together, showing that the sign of their charge has changed. They remain thus for an instant, and during another three-quarters of a revolution they again separate, and so on. But if the disc be turned rapidly, the leaves are no longer able to respond in this way to the changes of charge.

The appearance of the machine is clearly shown in the accompanying engraving. A central spindle carries a glass disc 16 in. in diameter. This is varnished, and has affixed to it a number of sectors of tinfoil. The sectors measure 4 in. radially, while in breadth they may vary from ¼ in. to 5½ in. Usually the sectors on one side of the disc are arranged to break joint with those on the other side, but this is not essential. Indeed in many respects the construction of the machine is very elastic, and many modifications are introduced. For instance, the number of tinfoil sectors may vary from 2 to 16 or more, on each side, and, as we have said, their relative positions on the two surfaces of the discs are not important.



Wimshurst Alternating Influence Machine.

The disc itself is mounted in the centre of, and in the same plane as, a wooden frame 20 inches square. This frame carries four inductors of the shape shown in the detatched view; they are 9¾ in. square, with one corner cut away to admit the spindle and boss of the disc. Two of the inductors are mounted on each side of the frame, at opposite diagonal corners; those at the side of the machine nearest the spectator are, say, at the upper left hand and the lower right hand corners. At the opposite side, the inductors are at the upper right hand and the lower left hand corners. Upon each inductor plate is a tinfoil patch of the shape shown, measuring 4 in. radially, and 7 in. circumferentially. Other inductors are provided, having upon them the smallest tinfoil patch practicable. Cemented over each patch is a wooden disc which on its face carries a bearing in which there rides a bent brass rod, having a plume of fine wires at its end, touching the glass disc at a point 90 deg. remote from the inductor, and opposite one of the inductors at the other side of the plate. The disc is thus touched on both sides in two places. It is driven by a cord from a small handwheel below, and revolves in the direction of the hands of a clock. To further vary the capabilities of the machine a bar of insulating material is made to carry two metal wire plumes at its ends, these having metallic connection with two terminals; this device takes the place of two of the inductors, and by its use a constant flow of electricity may be maintained.

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[1] *Engineering.*

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VOL. XI. NEW YORK, MAY 6, 1891. No. 157.

With a master's hand Faraday traced the strong broad outlines of the truth, and for fifty years philosophers have pondered on his facts and have made thousands of experiments, yet have failed to fathom their full significance.—Alfred M. Mayer.

EXPORT ELECTRICAL TRADE.

IT is evident that this country is destined to do a large export electrical trade before many years have rolled by—large not only in the aggregate of dollars but in the variety of articles listed. The protective policy, which still influences our commercial relations with friendly nations, lessens the market by rendering production more costly, but under a regime of Protection, tempered by Reciprocity, we may hope for much and secure not a little. The conditions of our electrical trade with Europe are pretty well-known and are fairly stable, for the reason that Europe can manufacture for herself very cheaply, and hence does not make much drain on us, except for inventions and models, but in Spanish America the demand for electrical apparatus is growing apace, and as yet comparatively little has been done to satisfy it. According to statistics compiled by the *American Exporter*, the electrical exports of the United States to Spanish America have been as follows:

1885	$191,961
1886	144,070
1887	171,701
1888	278,304
1889	398,067
1890	602,538

This is a most encouraging growth, but the latest figures to hand are even more satisfactory. During March the amount was $74,494, the value of 2,030 packages of goods, and during the first quarter of 1891 the total amount was $190,969, or more than any whole year up to 1888. If the same proportion be maintained throughout 1891, the year's electrical exports to that region will reach not less than $750,000.

We have reason to believe that the figure just named will fall below the mark. There is an active inquiry for electrical apparatus in Spanish America, and our friends to the South look more and more to this country as the place where they can deal best. We have, ourselves, been consulted twice this year in regard to two large electric railway plants for South America, and have the gratification of knowing that part of the apparatus for the first of them has been shipped this month. Other plans of the same nature are maturing, and it seems more than likely that in electric lighting, electric railroading and electric mining a large field is just opening up. In these departments, the contracts run up easily into large figures, and hence the exports of previous years, under the stimulus of closer trade relations, are apt to be doubled and trebled. It is to be borne in mind also that there is a large business to be worked up in miscellaneous articles of a smaller nature, which, when once known in the hot tropics and below the equator, will soon become household necessities.

ELECTRICAL BROOKLYN.

OUR contents this week happen to deal in an especial manner with the electrical interests of Brooklyn. One article illustrates and describes, in the language of a student, Mr. A. C. Boughton, the electrical work now being done so admirably at the Pratt Institute. Another gives an admirable idea of the fine new Excelsior plant just started in the Offerman building; while a third describes a novel and ingenious method of current distributionjust carried out successfully in Brooklyn, for the first time, by the local Edison Company. Evidently the big city across the bridge is well "in the swim" electrically speaking, and we are glad to note also that she is likely to have soon a complete system of electric railways. The old provincial tone of Brooklyn is still heard in the absurd objections and arguments urged by a handful of people, who on the same lines would oppose every single improvement and advance that the century has seen; but the Brooklyn public as a whole, intelligent, alert and full of pride in their beautiful city, appear to be well aware that with electric cars they make a step forward of enormous importance. Brooklyn will find in her new departure much the same benefits that have accrued to other great American cities. Take St. Paul for instance. In a recent editorial on the electric cars, the *Pioneer-Press* says that a return to horse cars would be simply intolerable. "It is an entire revolution in the methods and conveniences of street railway travel, and if ten years ago or even three we could have imagined in effect a system as convenient and as satisfactory as that which is now in full operation, we should have been willing to purchase it at almost any price." The *Pioneer-Press* goes on to show how safe, swift and pleasant electric car riding is, and closes with the remark that the change to it has been worth ten real estate booms to St. Paul.

We hope ere long to be able to quote like testimony from some of our Brooklyn daily contemporaries as to the results in their own wide-reaching city.

THE ECONOMICAL OPERATION OF SUB-STATIONS.

It has come to be recognized as a feature, not only of security but of economy in the operation of central stations that they should be combined by a system or network of conductors, wherever the conditions will permit of it. This is well brought out in the article by Mr. W. S. Barstow, which we print on another page. While the laying down of a large mass of copper such as that employed in the instance cited might, at first sight, appear ill advised, thorough and complete calculation proves the wisdom of this proceeding. The wasteful character of the steam engine operating at light loads, as in this case, showed the economy of operating dynamos of somewhat higher potential at the main station, driven by motors deriving current from the dynamos at the same station; this double transformation having been proved to be more economical on account of the high efficiency of both motor and generator than the operation of steam engines at sub-stations where the load is at present very light.

It is evident that the case cited is practically equivalent to the placing of a motor-generator at the sub-station, so far as the current itself is concerned; but by placing the motor and generator at the main station, the items of operating expenses are reduced to a minimum, and the sub-station is freed from the necessity of attendance inseparable in the operation of moving machinery.

We cannot dwell too strongly upon the necessity of submitting all problems of this nature to a thorough analysis before proceeding to actual work; and we believe the method pursued by Mr. Barstow might be found profitable in many other instances.

Patent Office Reforms.

The interest that electrical inventors take in the patent system is very natural, in view of the fact that but for the protection thus afforded, invention in the electrical field would cease. Hence we are all concerned to know just what the opposition to the patent system amounts to, and first what reforms, if any, are necessary, so that the bulwarks may be strengthened. Mr. T. Ewing Jr. has a clever and thoughtful article on the subject in this issue, and having been not long since himself an examiner in the Patent Office he speaks with fuller knowledge. The suggestions and criticisms he makes should help towards a clearer understanding of the questions involved.

The Underground Situation in Baltimore.

A situation which, as far as we know, is absolutely without parallel, has arisen in Baltimore in regard to placing wires underground. An appropriation of $50,000 having been made by the city council to put the fire alarm wires in the new telephone conduits, Mayor Davidson has opposed the expenditure on the ground that the city should wait until a complete, general system of conduits is available. Mayor Davidson can certainly claim the glory of being the first American mayor who didn't want to put the wires underground "right off," and we can only regret that the point of objection is not a better one. Baltimore or any other city will have to wait a very long time before a general, ramifying system is available, so that every telegraph and telephone wire can go into it, no matter where it runs; and the experience in New York goes to show that the fire alarm telegraph wires work to thorough satisfaction underground. Superintendent Smith is so well pleased that he is extending the underground service all the time with the aid of the telephone conduits, and we cannot but think that the modest outlay proposed in Baltimore would be a good investment for that city.

Protection Against Lightning.

The paper by Mr. N. D. C. Hodges, printed in this issue, on his new system of protection against lightning, adds some details to the description we gave of his ideas and methods two or three months ago. Mr. Hodges, having noticed that certain conditions and results attend a lightning stroke, has come to the conclusion that what is wanted is a protector that will dissipate the charge by means of its own dissipation. Such apparatus as he proposes would evidently be cheap, and there should be no difficulty in finding out whether the Hodges device is a protector that protects.

Electro-Static and Electro-Magnetic Induction.

While the paper by Mr. J. J. Carty, read before the American Institute of Electrical Engineers, based as it was on the results of actual experiments, left little doubt as to the comparatively larger influence of electro-static induction upon telephone circuits, as compared with that of electro-magnetic induction, the exact numerical details of the experiments undertaken to demonstrate this fact were wanting. During the discussion of Mr. Carty's paper, Mr. A. E. Kennelly showed briefly that, on theoretical grounds, Mr. Carty's deductions were well founded. Not satisfied with this, however, Mr. Kennelly has now undertaken the series of experiments which he details in another column, and which prove conclusively the points for which Mr. Carty contended and for which due allowance must now be made in practical telephony.

Alternating Influence Machines.

While the generators of static electricity have now and again undergone some changes in their details of construction, those heretofore employed have been designed only for the production of electric charges of the same polarity. Probably the most efficient static machine thus far designed is that of Mr. Wimshurst, and to his already admirable work, this gentleman has now added a machine which generates alternating static charges and which gives rise to a number of curious phenomena. Our readers will also be interested in the machine described in this issue by Mr. Tesla, who has also sought to obtain alternating current by electro-static induction. Now that this subject has been brought into prominence, we shall doubtless see a variety of methods proposed for accomplishing the same object.

ALTERNATE CURRENT ELECTRO-STATIC INDUCTION APPARATUS.

BY

Nikola Tesla

About a year and a half ago while engaged in the study of alternate currents of short period, it occurred to me that such currents could be obtained by rotating charged surfaces in close proximity to conductors. Accordingly I devised various forms of experimental apparatus of which two are illustrated in the accompanying engravings.

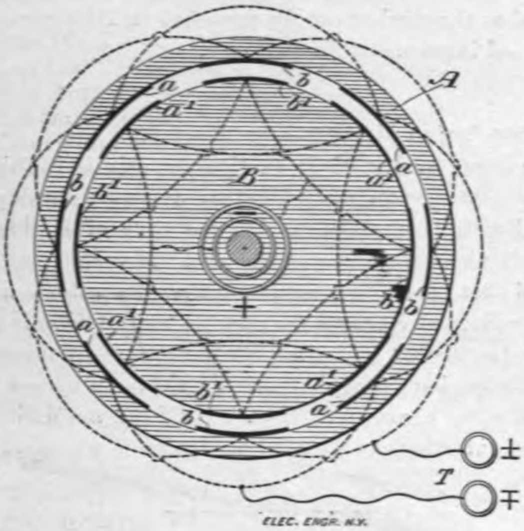


FIG. 1.—TESLA ALTERNATING ELECTROSTATIC INDUCTION APPARATUS.

In the apparatus shown in Fig. 1, A is a ring of dry shellacked hard wood provided on its inside with two sets of tin-foil coatings, *a* and *b*, all the *a* coatings and all the *b* coatings being connected together, respectively, but independent from each other. These two sets of coatings are connected to two terminals, T. For the sake of clearness only a few coatings are shown. Inside of the ring A, and in close proximity to it there is arranged to rotate a cylinder B, likewise of dry, shellacked hard wood, and provided with two similar sets of coatings, a^1 and b^1, all the coatings a^1 being connected to one ring and all the others, b^1, to another marked + and —. These two sets, a^1 and b^1 are charged to a high potential by a Holtz or Wimshurst machine, and may be connected to a jar of some capacity. The inside of ring A is coated with mica in order to increase the induction and also to allow higher potentials to be used.

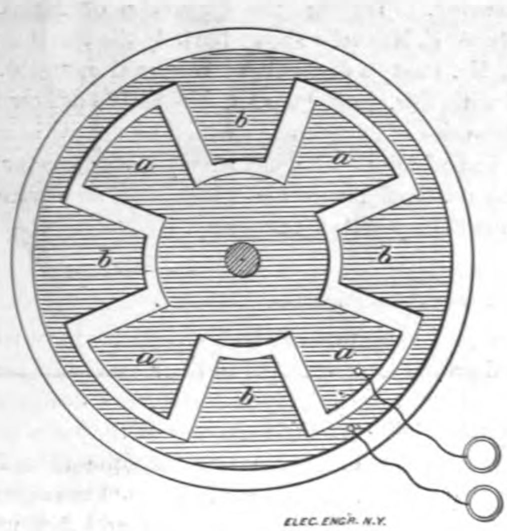


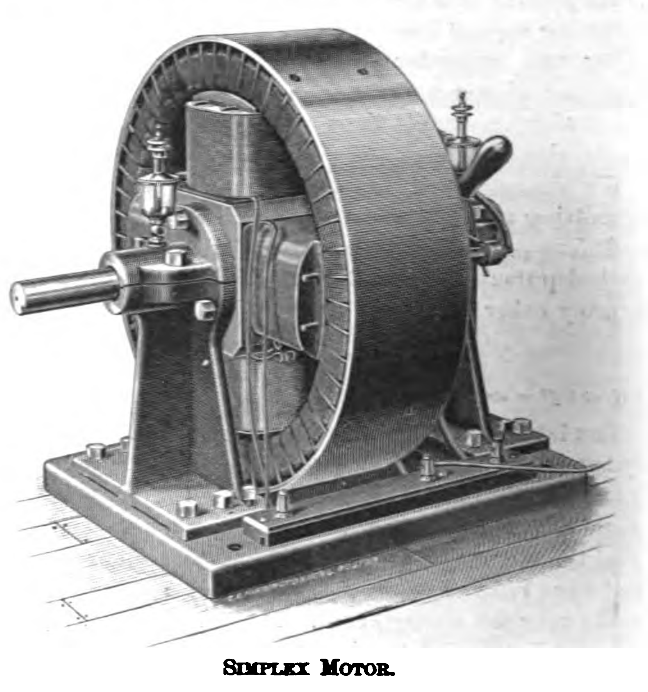
FIG. 2.—TESLA ALTERNATING ELECTROSTATIC INDUCTION APPARATUS.

When the cylinder B with the charged coatings is rotated, a circuit connected to the terminals T is traversed by alternating currents. Another form of apparatus is illustrated in Fig. 2. In this apparatus the two sets of tin-foil coatings are glued on a plate of ebonite, and a similar plate which is rotated, and the coatings of which are charged as in Fig. 1, is provided.

The output of such an apparatus is very small, but some of the effects peculiar to alternating currents of short periods may be observed. The effects, however, cannot be compared with those obtainable with an induction coil which is operated by an alternate current machine of high frequency, some of which were described by me a short while ago.

THE SIMPLEX MOTOR.

A new motor presenting in its general appearance a contrast to those now in general use, has recently been brought out by the Simplex Motor Company, of Boston, and is being exhibited at their office at No. 113 Devonshire street, in that city. As will be seen from the accompanying illustration, the armature is placed on the exterior of the field, the coils of which are held in place by pins. The field magnet cores project through the coils to decrease the air space in the magnetic circuit. The armature, being in the form of a ring, can be extended to any diameter, will run at a very slow speed, and, therefore, produces little friction on the bearings.



SIMPLEX MOTOR.

The Simplex motor can be applied to vehicles in several ways, either directly, by making the motor a wheel of the vehicle, or it may be suspended from the vehicle and directly connected to the axle, or it may be mounted in the cab of a locomotive, and connected to the axle by means of side bars, as in the steam locomotive, or by belting, the advantages of this method being that the motor is high from the ground, and is thus protected from moisture and dust, while at the same time, every part is open to view and as accessible as though it were stationary and located in the shop.

The first two of these methods involves no loss whatever in the transmission of power, and the last, only a very slight loss.

THE EXCELSIOR PLANT, OFFERMAN BUILDING, BROOKLYN.

Offerman Building, Brooklyn.

ONE of the most striking and beautiful of the new edifices in Brooklyn is the Offerman Building on Fulton street, just above the City Hall, erected for and now occupied by the enterprising dry goods house of Wechsler & Brother. As those who are familiar with Brooklyn, know, the popular stores there clustered down near the ferry until a few years ago; but the growth and drift of the city has carried trade into higher Fulton street, where palace after palace has risen to ornament and dignify that thoroughfare. While in the old stores now being deserted, the electric light had already secured approval, in the new ones its great value and economy are so thoroughly recognized that nothing but a plant of the utmost perfection and efficiency will satisfy the proprietors of these huge establishments. Thus it happens that in the graceful and harmonious Offerman Building here shown, a plant has been installed which is without question the largest and finest of its kind in the city, and probably for its special purpose the most complete in the country. The owners may well be proud of it, and one need not be surprised to find it taken as a model in other work of this nature about to be attempted.

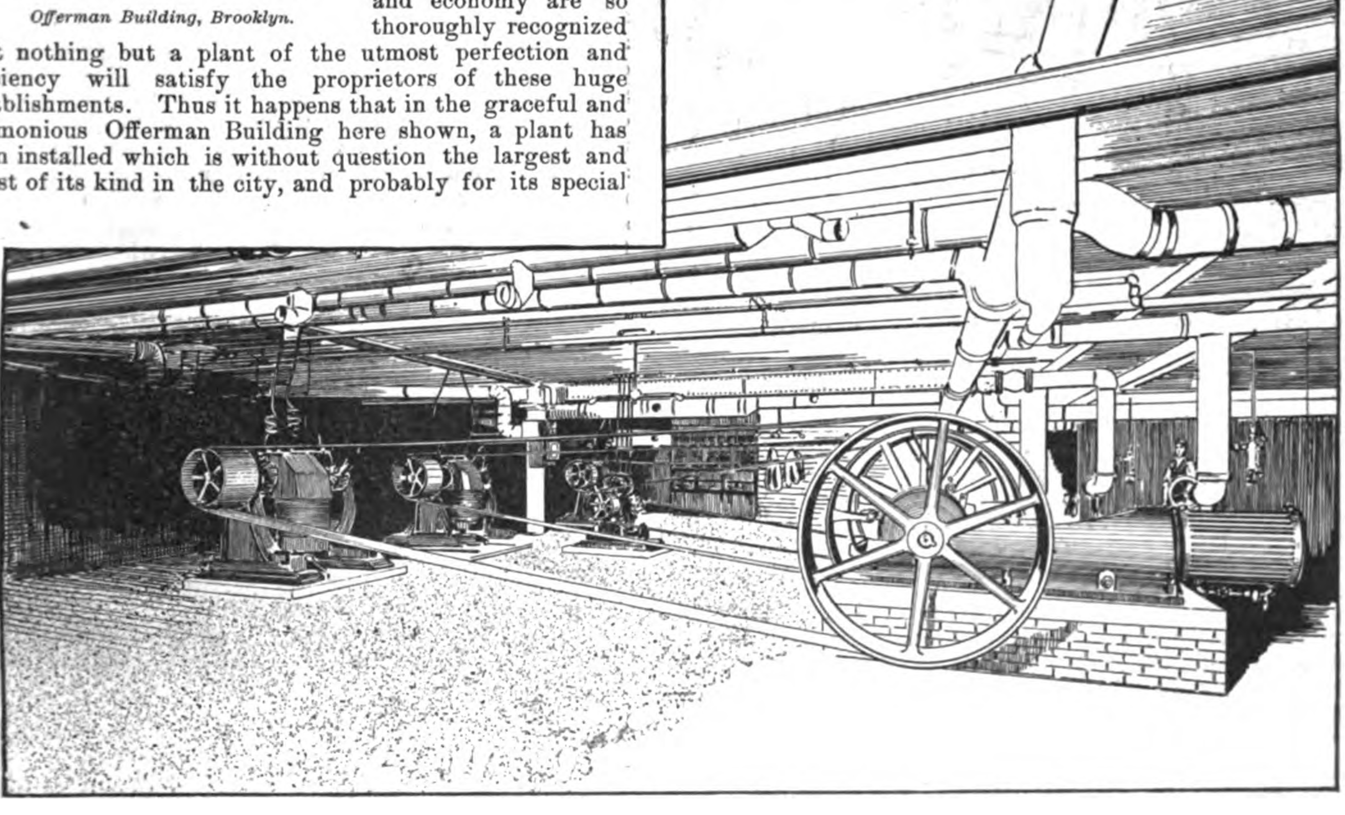


FIG. 1.—DYNAMO ROOM, EXCELSIOR PLANT, OFFERMAN BUILDING, BROOKLYN, N. Y.

This isolated plant has been installed by the Excelsior Electric Light Co., a Brooklyn concern which if it had no other achievements to point to could rest very comfortably on its local laurels, as the building is only the latest of a long series in Talmageville to receive equipments from Mr. Hochhausen. A view of the dynamo room is shown in Fig. 1. It occupies a large portion of the sub-basement, stands on solid masonry, and is so arranged as to admit of extension at any time. There are now installed three Excelsior incandescent machines of 600 lights each, the output being 350 amperes at 110 volts for each dynamo. These machines, and an Excelsior arc machine giving 30 lights of 2,000 c. p. each, are driven by three Ball automatic high speed engines of 65 h. p. each, steam to which is furnished from 4 Vogt Bros., 120 h. p. steel boilers. All the dynamos are thoroughly insulated from the base and ground.

From the dynamos the circuits are carried to the handsome switchboard shown in Fig. 2. Thence the circuits run to a separate switch on each of the 7 main floors. The switchboard has its full complement of ammeters, voltmeters, etc., and all the switches are carbon break, the disposition being extremely convenient and safe.

The building is now wired up for over 2,000 incandescent lights. The wires used for these is Grimshaw white core, laid in the walls. The arc wires are carried on insulators. A very effective disposition has been made of the incandescent lights, some 1,800 of which are grouped on handsome chandeliers distributed liberally on each floor. One very successful effect is obtained in the domed court which occupies the central space of the building, and has at each floor a gallery around it from which one can survey the brilliant, shifting throng below. On the ceiling of each floor, around the gallery rim, are placed some 40 or 50 lamps, and these when burning make a series of glittering concentric rings of light. The scene as one's glance travels through these narrowing constellations up to the sparkling dome that crowns the rotunda, is not easy to surpass in its grouping and color. Elsewhere, as in the glassware department and the boudoirs and salons, a most skillful and charming disposition of the lights has been made, each lamp being utilized to its fullest capacity for effective service in illumination whether of nooks and corners or of broad floor spaces and passages.

It may be added that the utmost care has been exercised in every detail of the installation, no pains or expense being spared by the Excelsior company to sustain its high reputation, and to give the building a plant of the greatest possible economy and efficiency in operation. The plant has already been started well up to its capacity and is running so smoothly and steadily that the soft gleam of the lamps is the only sign of its existence.

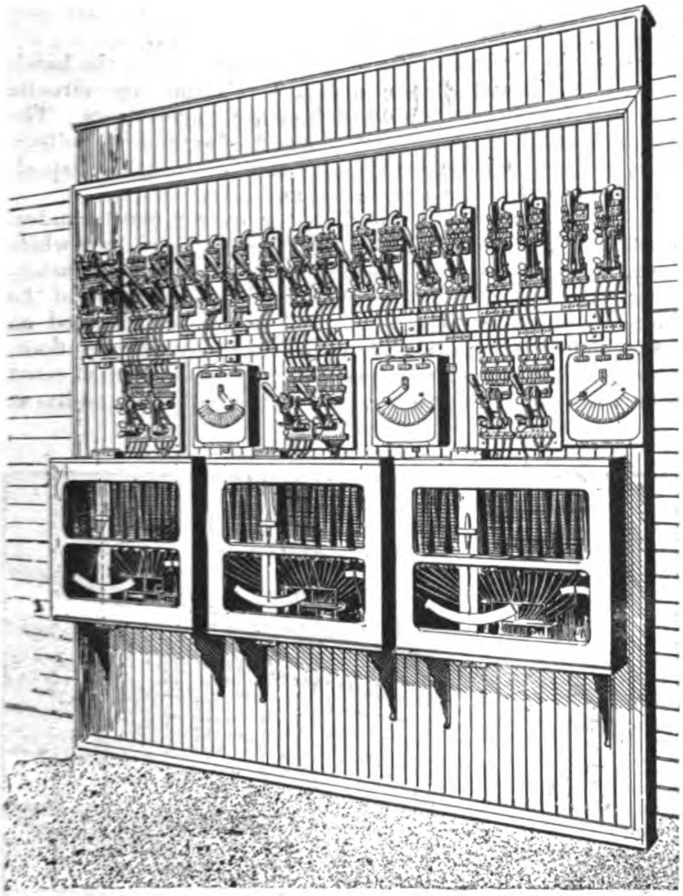


FIG. 2.—SWITCHBOARD, EXCELSIOR PLANT, OFFERMAN BUILDING.

THE WEST END PFINGST MOTOR CAR.

The West End company of Boston, in order to test the relative efficiency and economy of operating their cars by two motors mounted on the truck in the ordinary manner, or of one large motor mounted in an independent car, have had constructed in their own shops an electrical locomotive or motor car which has been put in operation upon their lines.

This new machine was designed and built by Mr. L. Pfingst, master mechanic of the West End company. The car is not designed to carry any passengers.

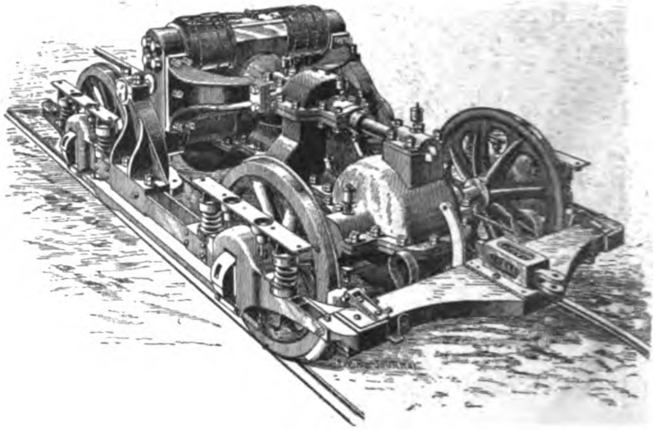
The accompaning engraving shows the method of gearing the armature to the axle, all the parts being unusually heavy in order to secure weight for traction and to insure durability. The motor is of the Siemens type and is calculated to develop normally forty h. p., the armature making from 1,100 to 1,200 revolutions per minute. At a speed of twenty miles per hour the armature makes 1,500. The commutator has seventy-two segments.

The fields are of the best wrought iron and are three feet three inches long, ten inches in diameter at the spools and twelve inches through at the pole. The field bobbins are wound with twelve layers of No. 9 wire, B. & S. gauge three loops being taken off at the sixth, eighth and tenth layer. All field connections are in multiple. The armature is fourteen inches in diameter and is wound with the double No. 8 wire, B. & S. gauge.

The power is transmitted to the intermediate shaft by a spur pinion on the armature shaft which in turn transmits the power to both car axles by bevel pinion and gear. The armature pinion is eleven inches in diameter and the reduction from armature to intermediate shaft is one to two and from the intermediate shaft to car axle one to four.

All the gears and intermediate shafts are entirely enclosed in oil-tight castings made of inch and a-quarter cast iron, none of the working parts being exposed except the commutator, armature and a portion of the armature shaft.

The following account is given of a run made on the evening of April 6, during which the readings were taken by Professor Hooper, of Tufts College, and Mr. Pearson, the electrician of the West End company. The run was made from the Bartlett Street stables of the company to the Tremont House, a distance of two and a half miles, and return, the return being made without a load. The outward trip was made with three cars in tow, each weighing six tons and loaded with thirteen tons of meal, a total load of forty-three tons. The run was made at a busy hour on the usual time of the ordinary cars. The only incident of the outward trip was the blowing out of a fuse while attempting to start on a grade crossing at Boylston Street. The capacity of the fuse was then increased, and the Tremont House reached without further trouble. The average flow of current for the trip with the load was sixty and nine-tenths amperes or thirty-six h. p. The maximum current used during the trial, including the grade, was 240 amperes. With a load of thirty tons the average current consumed, including down grades where train was in motion but had no current, was found to be about eighty-five amperes while the horse power used was 47.6. The maximum current was 350 amperes. This was consumed in starting after the car had stopped on a grade at a crossing. On the return trip, two and a half miles, when the car was running light the average current consumed by motor including down grades when no current was used was thirty amperes or eighteen h. p. A further exhaustive test will be made before it will be decided to operate all the cars in this manner, but another motor is already under construction which will embody such improvements as have been suggested by the operation of the one herewith illustrated.



WEST END PFINGST MOTOR CAR.

THE ELECTRICAL UTILIZATION OF NIAGARA.

The fifth annual report of the Niagara Falls Park Commissioners, presented the Ontario Legislature, in reference to utilising the power of Niagara Falls, says the Commissioners, with the consent of the Government, have made an agreement with a strong syndicate of English capitalists, the owners of large electrical works at Deptford, England, who have deposited $30,000. which is to be forfeited if the operations for the utilization of the power of Niagara Falls are not begun before March 1, 1892.

THE RUSSELL DISC CARBON ARC LAMP.

For some months there has been considerable interest shown in the Russell arc lamp, and as no complete descrip-of the lamp has as yet appeared, we give below the details of construction.

Fig. 1 shows the general appearance of the lamp, showing the disc carbon used for the positive pole.

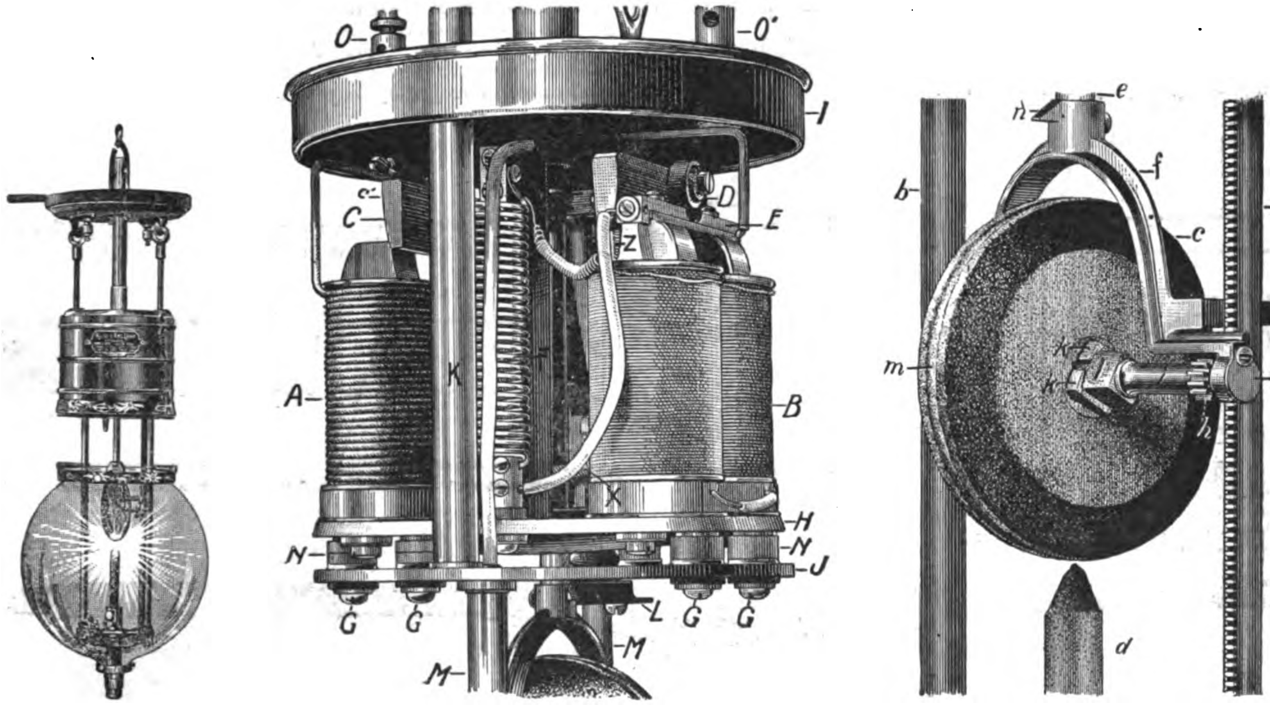
The action of the lamp will be readily understood by reference to Fig. 2. When the current goes through the series magnets, A, the armature C is attracted, which opens the cut-out E, by lifting out the metallic button D, and lifts the carbon rod by a link, and thereby strikes the arc. As the arc lengthens, its resistance is increased, and more current goes through the shunt magnet B, attracting its armature, and thereby allowing the carbon rod to drop a little. It will be seen that thus there is an electrical balance maintained at all times, between the two armatures, C and D, of the series and shunt magnets. The armatures are attached to the rocking lever by a small screw, which can be adjusted to bring the armature more or less into the field of the magnet, and by means of which a most delicate adjustment of the lamp can be obtained

Fig. 3 shows the details of the revolving feed for the disc carbon. The carbon rod *e* enters the socket *n* of the yolk *f*, which carries the spindle *i*, carrying a small pinion *h* gearing into a ratchet on one of the frames of the lamp *a*. The disc carbon is renewed by unscrewing the nut *l* which allows the two parts *k k* to contract, when the disc can easily be slipped off or on. The arc is maintained between the disc and the negative carbon *d*, and as the lamp feeds, the disc drops and is at the same time revolved by the pinion gearing into the rack, the lug *g* always keeping the pinion in close gear with the rack.

The Russell lamps develop 1,200 or 2,000 c. p. by actual photometer test, taking $6\frac{8}{10}$ amperes or $9\frac{6}{10}$ amperes, respectively, with an average voltage of 46 volts. They are made in four different sizes, to burn different periods of time. The lamp calculated to burn 8 hours is $32\frac{1}{2}$ inches long, and uses a disc carbon 3 inches in diameter; the 12 hour lamp is 35 inches long with a 4 inch disc: the 18 hour lamp is 42 inches long with a $4\frac{1}{4}$ inch disc; and the 24 hour lamp is 49 inches long with a $4\frac{1}{2}$ inch disc. The disc carbons are all $\frac{5}{8}$ inch thick, and the negative carbon is $\frac{5}{8}$ inch diameter, although smaller carbons can be used successfully.

The lamp is made of the best material and workmanship, and is all machine made, each part being interchangeable.

The lamp, we may add, is manufactured by the Russell Electric Co., of Boston, Mass.



Figs. 1, 2 and 3.—The Russell Disc Carbon Arc Lamp.

ON FURTHER CONTRIBUTIONS TO DYNAMOMETRY.[1]

The object of Mr. Blakesley's paper was, in the first place, to show what sort of physical quantities could be advantageously evaluated by using electro-dynamometers of two coils of low resistance in circuits conveying electric currents. The meaning of a dynamometer reading was explained to be the mean value of the product of two currents, either steady or alternating, or one steady and the other alternating, undergoing any periodic variations with sufficient rapidity. In mathematical language such an instrument measured $\frac{1}{T}\int_0^T C_1\, C_2\, d\, t$, where C_1 and C_2 were the instantaneous values of the currents in the two coils, including, of course, the common case where these currents are identical.

Any physical quantity whose value was such a product, $C_1\, C_2$, multiplied into something which was independent of the time, and which, therefore, on integration came outside the integrator, was well adapted to have its mean value given by such instruments. Power was such a quantity, being merely $(\text{current})^2 \times$ resistance. The square of an E. M. F. was another such quantity, but he did not wish to restrict the method to such evaluations.

It follows that any quantity whose instantaneous value can be expressed by terms each quadratic in current, and whose other factor was independent of time, could have its mean value expressed in dynamometer readings. In addition, the particular place and mode of coupling of the dynamometers was indicated by the instantaneous equation, as well as the factor to be applied to each reading. *Thus the equations are made to indicate the practical arrangements to be adopted, and the use to be made of the observations in each case.*

Examples were given for the cases of transformers in series and parallel, and special applications of the method were suggested in the measurement of the power employed in such diverse apparatus as voltmeters subject to direct or variable currents of any sort, welding machines, parallel generators, tuning-fork circuits, vacuum discharges and imperfect condensers. For parallel generators, the power of each could be separately estimated, and in the case of electric welders, the power employed in the welding circuit was shown to be measurable without introducing any resistance whatever into that circuit.

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[1] Abstract of a paper read before the London Physical Society.

THE MULTIPLE DUCT SYSTEM OF THE INTERIOR CONDUIT AND INSULATION CO.

Our readers will remember the description, in a recent number of THE ELECTRICAL ENGINEER, of the single duct system of the Interior Conduit and Insulation Company. As a result of an elaborate series of experiments, this company has now produced a "multiple duct" system, details of which are shown in the accompanying illustrations. This consists of a series of highly insulating water-proof tubes, which form individual channels for the reception of whatever electrical conductors may be employed, thus providing for the drawing in, or withdrawal of, conductors at any time, and rendering them as accessible for renewal and repairs as if placed on the surface itself.

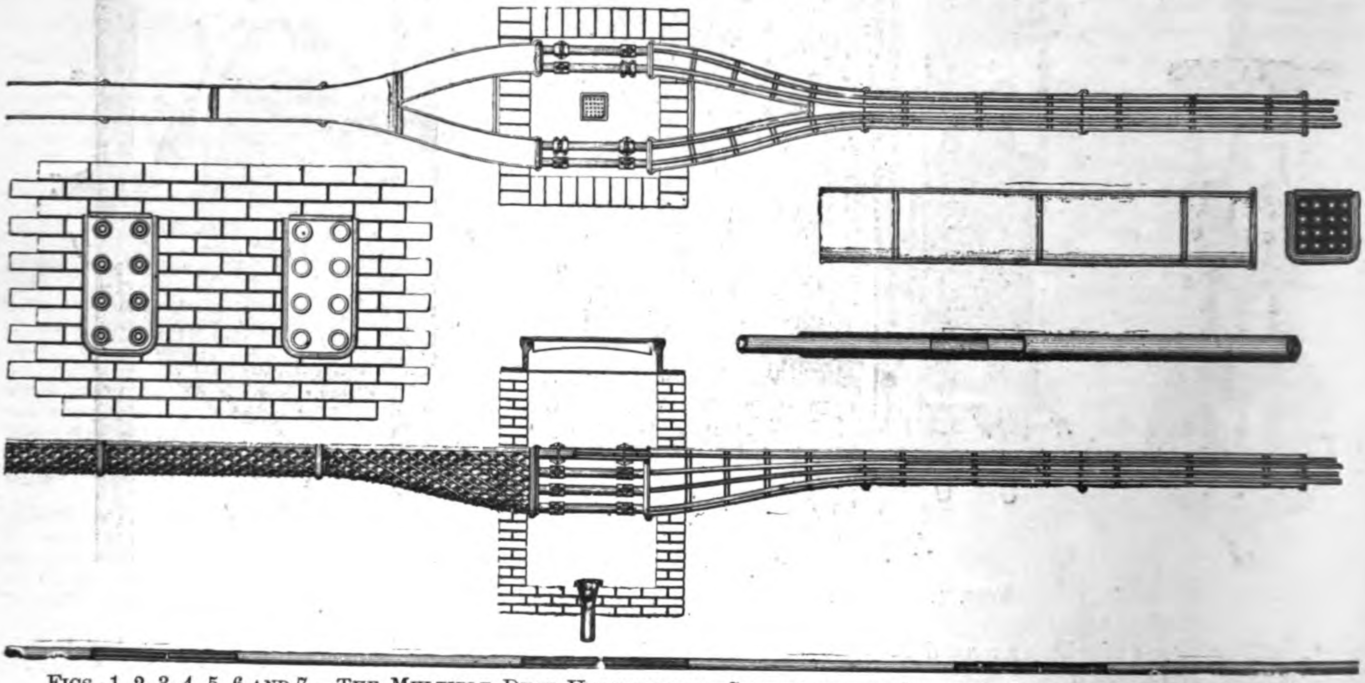
The conduits being composed of highly insulating material throughout their entire length, and being absolutely air tight and moisture proof, it is possible to employ bare copper conductors in place of the lead sheathings commonly used for underground work.

In its physical characteristics the multiple duct system differs from the ordinary iron, wood, cement and other conduits, in that, while they only contemplate ducts of uniform and large diameter, each accommodating a considerable number of wires, these conduits provide an individual duct, for each and every wire and cable employed. In the important element of insulation, however, it differs in a radical degree, as it provides in the conduit itself, without special investment, an insulation ample for all purposes.

The conduit may consist of any desired number of individual tubes or ducts continuous from one manhole to another, no joints or couplings being employed; thus a fruitful cause of leakage and consequent deterioration is eliminated. The method employed to convert the tube sections into continuous unbroken and unjointed ducts constitutes one of the important elements of the system. The general method is as follows:

A light cast-iron interlocking box Fig. 1 and 2, is first laid in the trench and a series of the company's telescopically formed tubes of any given number, length and diameter are then racked together within the iron boxing, so as to be held apart a uniform distance by insulating supports. The interstices between the individual tubes, and the tubes and boxing are then filled in with an insulating compound, composed for the most part of coal tar pitch, Fig. 3. This is poured in a liquid state and quickly solidifies, presenting a substantial body composed of a highly insulating material, through which run the clear straight duct interiors.

The telescopically formed ducts consist of two tubes, Fig. 4, one fitting within the other, the internal diameter of the smaller being just that called for by the requirements of the use to which they are put. At the moment of laying, the inner tube is coated with an insulating compound and then telescoped into the exterior tube to just one-half of its length; thus each duct so formed of two complete tubes cemented with a superior insulating compound, becomes, to all intents and purposes, a continuous unbroken tube, without sleeves or joints and possessed of very high insulating properties.



FIGS. 1, 2, 3, 4, 5, 6 AND 7.—THE MULTIPLE DUCT UNDERGROUND SYSTEM OF THE INTERIOR CONDUIT AND INSULATION CO.

The manhole, Figs. 5 and 6, is a simple construction of brick cemented to protect it, from the exudations of the soil, for the sake of cleanliness. The section of the general containing box or conduit entering the manhole, is expanded in a forked form and also in a vertical line, as shown in the accompanying figures, for the purpose of providing greater space around the duct ends for more convenient manipulation.

The end of each section entering the manhole is provided with a cast-iron head, on the face of which are short pipe projections, which are carried across the manhole to the opposite face plate by sectional iron pipes enclosing a section of the insulating tube. These sectional pipes are adapted for easy and quick removal in order to render the conductors readily accessible. Thus the continuity of each duct is preserved across the manhole, which may therefore be left open with impunity in all kinds of weather.

Lamp posts, feeder posts, elbows and other branch connections are so constructed as to be minor extensions of the system in its every feature. They consist of iron boxing or piping filled with insulating compound and joined to the conduit proper by elbow extensions, thus providing for the drawing in of the conductors from the nearest manhole.

THE ELECTROLYTIC GENERATION OF HYDROGEN AND OXYGEN.

In a paper recently read before the Société Française de Physique, Commander Renard described his investigations on the electrolysis of water on a commercial scale, which he commenced as far back as December, 1887. Taking the back E. M. F. at 1.5 volt, and the total plant efficiency at only 50 per cent., 35.3 cubic feet (one cubic metre) of hydrogen can be produced for every 10 horse power hours; and taking the coal consumption at 2.2 lb. (one kilogramme) per horse power hour, the cost of fuel for every thousand cubic feet at atmospheric pressure of the mixed gases comes out in France at between 45 cents and $1.20, according to the price of coal. To make the electrolytic production of these gases a commercial possibility, it is necessary to avoid the use of costly platinum electrodes and of airtight partitions for collecting the gases. Commander Renard employs an alkaline electrolyte (caustic soda, 13 per cent. solution) and is, therefore, able to substitute cheap cast-iron electrodes for platinum. As to the vessels for the collection of the gases, he finds that so long as they have a *capillary reaction* Δ equal to a few centimetres of water, the hydrogen and oxygen do not mix. Commander Renard employs porous pots of asbestos fibre, which are able to withstand a pressure of from 30 to 50 cms. of water without permitting the passage of the gases. The actual commercial apparatus used at the Chalais works is as follows: A large cylinder of common sheet iron serves at the same time as the containing vessel for the electrolyte and as the negative electrode. The positive electrode is a perforated iron tube, fixed on to an insulated lid, which fits hermetically on to the top of the containing vessel. This electrode is surrounded by a large asbestos bag. Two voltameters of this kind have been in continuous work at Chalais for some six months, and at the end of this period both the electrodes and the asbestos bag were in perfect condition. The gases given off are pure, and there is no ozone. According to Commander Renard a battery of 36 large voltameters could generate about 200 cubic feet of hydrogen and 100 cubic feet of oxygen per hour, which could be compressed to a pressure of from 120 to 200 atmospheres in steel tubes, and utilized for therapeutic, laboratory, metallurgical, and other purposes. The *total* cost of these gases, ready for use in steel bottles at a pressure of 120 atmospheres, when produced on a sufficiently large scale, is estimated at from $2.90 to $3.50 per thousand cubic feet.

THE PACKARD VACUUM PUMP FOR EXHAUSTING INCANDESCENT LAMPS.

WHILE the mercury pump leaves nothing to be desired as a method of obtaining a high vacuum, its employment in completely exhausting vacuum lamps is tedious and expensive. In order, therefore, to expedite and cheapen this important part of lamp manufacture, mechanical vacuum pumps are now extensively employed to remove the larger part of the air contained in the lamps, leaving the mercury pumps to complete the vacuum required. Probably the most extensively used vacuum pump for this class of work is the Packard Vacuum Pump, built by Mr. Norman Hubbard, of 93 Pearl street, Brooklyn, N. Y. Our engraving, Fig. 1, shows the No. 4 pump, and as will be seen, the cylinders are placed vertically in a cast-iron box which serves as a bed plate and water-jacket, and on which the frame and working parts are mounted. Each cylinder is entirely independent of the others and can be used separately or connected up as required. The suction pipes are connected at the bottom of the jacket by means of ground unions which are provided with traps to arrest any mercury or dirt, and the exhausts are piped to a pot which acts as a trap to catch the oil used in lubricating the cylinders, which is saved and may be used over again. No water is used in the cylinders.

The valve motion is on the principle of the well-known Ritchie valve gear, but containing none of its complication. All the valves are opened and closed automatically, not requiring an air pressure below them to do this work. The main valve stem does not pass through the piston head. The clearance in the cylinders is reduced to a minimum, being generally less than $\frac{1}{16}$th of an inch, and no liquid is used other than sufficient oil to insure proper lubrication.

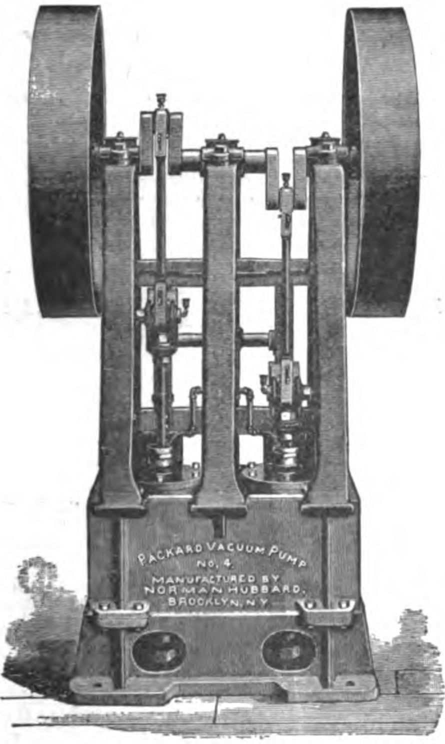


FIG. 1.—THE PACKARD VACUUM PUMP FOR EXHAUSTING INCANDESCENT LAMPS.

The valves in the piston head have their seats close to the bottom, and are entirely inclosed in the body of the piston, rendering impossible the breakage or giving out of the valve. The exhaust valves are contained in a separate bonnet bolted to the cylinder head. This bonnet has a screwed cover, by removing which the valves can be lifted out.

The company claim that (the barometer being at 30 inches) a vacuum exceeding 29½ inches is easily obtained.

The Packard pumps are built in a variety of sizes, the smaller ones being designed for the preliminary exhaustion of the lamps. The larger sizes are designed for the operation of the ordinary automatic Geissler pumps, where the mercury is raised and lowered by alternately admitting the atmospheric pressure and producing a vacuum above the mercury in the lower bulb. The method of connection of the Packard pump with the mercury pump is shown in Fig. 2.

These pumps are in regular use in every incandescent lamp factory in this country, with one exception; among them, in that of the Sawyer-Man Electric Co., where no less than 23 of them are in operation; the Thomson-Houston Electric Co. operate 19; the Perkins Electric Lamp Co., 10, etc. Not a few, also, are in use abroad, where their merits have been recognized.

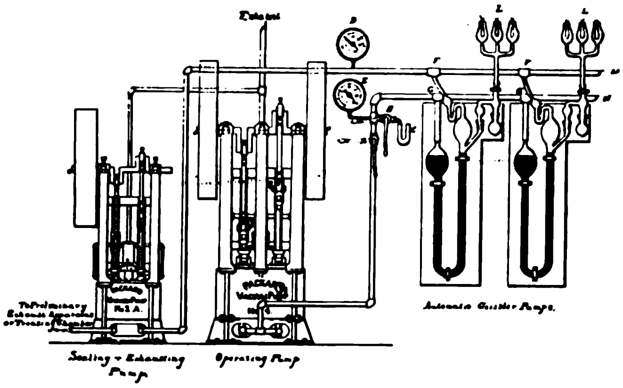

Exhaust
L
L
To Preliminary Exhaust Apparatus or Treating Chamber
No. 2 A.
Sealing & Exhausting Pump
Operating Pump
Automatic Geissler Pumps.

FIG. 2.—THE PACKARD VACUUM PUMP FOR EXHAUSTING INCANDESCENT LAMPS.

LIGHTING THE HARLEM TUNNEL.

The New York Central Railroad has begun experiments with a view to lighting the tunnel.

The west-side rock-cut tunnel, through which its north-bound local trains run, has been lighted with incandescent electric lamps of about 40 c. p., placed alternately on either side of the track, about 125 feet apart.

Reflectors placed on the south side of the lamps prevent the glare of light from reaching the eyes of the engineer or fireman of approaching trains, and throw the light forward on the track.

The lamps are placed three and a half feet above the rails, and their light should not interfere in any way with the signal lamps, which are placed much higher.

It has been alleged, and denied, that the New York Central officials have tampered with the arrangements so as to make it appear that the lighting did more harm than good by blinding the engineers. There is not the slightest reason why these small incandescent lights, properly placed, should have the effect of blurring or rendering useless signal lights.

WONDERS OF ELECTRIC TRACTION IN WACO, TEX.

The Waco *Daily News* describes in glowing colors the system upon which the new electric railway in that town will be operated. According to this facetious exponent of the Sunny South, "the cars will run alone except the passengers." Should any one neglect to deposit his fare, an automatic monitor will run along a wire, extending around the car, and touch him gently but firmly on the elbow, while the words "pay your fare" will appear in a frame at the end of the car. If this warning be unheeded, the letters glow more and more fiercely, until they finally disappear in a jet of flame, and the name of the delinquent takes their place. At the same time a fiery ring fastens about his neck, and, despite his struggles, he is dragged to the rear platform and thrown into the street. In case the man is a dead-head, however, the monitor recognizes him at once, and the word "complimentary" appears in the frame.

The cars stop and start themselves automatically, and should anything get out of order, the trolley arm connects with a telephone wire, and explains the difficulty to the one man employed by the company at the central station, who hastes lightly to the scene, and all is well.

MR. MCCARTHY, late of the Thomson-Houston Electric Co's. railway department has joined the Westinghouse Co. as special electric railway agent.

ELECTRICITY IN MILL WORK.[1]

BY O. S. HUSSEY.

The province of this article is not so much the consideration of the subject of long distance transmission as it is to show, if possible, how electric power can be used advantageously in performing some of the work in and about a mill, now done by other means.

This work may be divided under the following heads:—1. Electricity as applied to isolated motors, located in different parts of a mill, and used to drive lines of shafting, separate machines, etc. 2. Electricity as applied to driving tram-cars suitable to handling all classes of goods both in the mill and about the mill yard. 3. Electricity as applied to hoisting machinery of all descriptions, including elevators, whip and drum hoists, etc. 4. Electricity as applied to pumping machinery.

Assuming that there is sufficient power at the mill, either steam or water power, let us then consider what is necessary in the way of generators for supplying power to the different electrical apparatus, wherever located.

For transmitting over distances such as would occur about a mill, both generators and motors should be wound for 500 volts, insuring economy in copper wire without danger to persons handling the apparatus, and each machine should be driven from the existing water or steam powers through the medium of a friction clutch. As a rough approximation, 100 feet of shafting, 3 inches in diameter, and making 120 revolutions per minute, requires 1 h. p. to overcome its friction, under conditions of fairly good alignment and good care. Should this shafting get out of alignment, as is frequently the case, its frictional resistance would be proportionally increased.

It has been estimated that from 30 to 50 per cent. of the power generated in mills and factories is unremunerative, because of the wasteful method of driving in vogue at the present time. Should a judicious arrangement of electrical transmission be employed, on the contrary, fully 85 per cent. of the power developed by the wheels would be expended in useful work. That the transmission and distribution of power by electricity is a profitable investment, is proven by the large number of electric stations scattered throughout the country. Not only can power be saved by electrical transmission, but also a large amount of space is made available for other purposes.

Another point which should be considered by mill men, and which would seem to be a very essential one, is this:—by a subdivision of shafting into small units, a much more complete control is had over it in case of accident or of any breakdown which is liable to occur, and which means, as mills are driven to-day, the shutting down of the entire room, and sometimes of an entire factory, at an immense loss while repairs are being made. On the other hand, should motors in small units be used, simply that portion of the room in which the breakdown occurred would be stopped, the rest of the mill running as before.

As an electric motor has but one running part, the armature, there is very little about the machine to get out of order, but should an accident happen to any part of it, this can, under ordinary circumstances, be quickly repaired.

Automatic regulation of speed of less than 2 per cent. variation is obtained on all first class motors, no matter what the variations of load may be. This feature is of special value, as it permits of the simplest possible construction of the motor, and at the same time secures an automatic regulation of speed well within the range of that which is guaranteed for the best regulated high speed steam engines.

The next head to be considered is the application of electricity for driving tram-cars The electric mill tramway, in its sphere, has operated fully as successfully as the electric street railway, although its adoption has not been so general. A mill tramway is practically a modified electric street railroad, the principle of propulsion being the same. Usually a single overhead trolley system is used, as in street railway work. Where the motor car is to be run inside of buildings, however, two trolley wires are used, in order to have a thoroughly insulated system throughout and to do away with any sparking which might occur between the rails of the track and the revolving car wheels.

The amount of power generally used by motor cars in ordinary tramway work is either of 3 or 6 h. p.; the former easily hauling a load of 5,000 pounds, and the latter a load of 10,000, exclusive of the weight of the car, at a speed of four miles per hour on a level and straight track.

For hauling heavy loads, such as loaded freight cars, electric locomotives of 30 h. p. and over have been designed. All these machines are so constructed that the platform of the machine itself is available for loading, if so desired. The small motor cars are built to operate on any gauge of track from 30 inches to the standard 4 feet 8½ inches.

The third head to be considered is the application of electricity for hoisting apparatus. For hoisting work, machines are now made of almost any size and power, from a 3 h. p. whip, suitable for handling light loads at a high rate of speed, to 80 and 100 h. p. machines for heavy work.

These hoists are particularly desirable for store houses and warehouses, because they can be mounted upon trucks and easily moved from one portion of the building to the other, wherever needed. A Thomson-Houston hoist is in use on one of the large docks in Brooklyn. The wharf is wired in all parts, plugs being inserted at intervals so that the supply of power can be obtained from the main wires at almost any point, and at a moment's notice. On Constitution Wharf, in Boston, a large 45 h. p. motor is used to drive an elevator and also a long line of shafting running the entire length of the building, from which four friction whip hoists are operated for handling light loads rapidly. These small friction whips should receive the approval of mill men for use in cotton, wool, or cloth storehouses. To-day, in a great many places, a dozen or more men are required to do the same amount of work that two men with a whip hoist could perform more quickly and easily.

Within the past year electricity has been applied successfully to elevators, and special machines have been designed for this work. The hoisting drum is mounted upon the same bed plate as the motor, and is driven by means of worm gearing. The worm-shaft is connected directly to the armature shaft by a coupling, insuring positive motion between the motor and hoisting drum.

The fourth and last head to be considered is the application of electricity to power pumps. While this question may not have so much interest to mill men in general as the previous points brought up, still it may be of sufficient interest to warrant the mention of a form of pump which is being used to a great extent by the Thomson-Houston Motor Co. in connection with it motors. This pump is manufactured by the Goulds Manufacturing Co., of Seneca Falls, N. Y., and is of the triplex single acting type. Three single acting plungers, with their cranks hung from the main shaft at 120 degrees, are worked in three vertical cylinders. This arrangement is the best for electric work, as it insures an almost constant load upon the motor at all points of the stroke. The Goulds Manufacturing Co. makes pumps of this design in all sizes from 2x4 inch cylinders for light work to a 12x12 inch in course of design The efficiency of these electric pumps has been shown by actual test to be fully equal to that of a steam pump of corresponding capacity, and working under similar conditions.

Electric pumps are intended to supersede steam pumps of any size, particularly if the location of the pump is any great distance from the source of power. With the efficiency the same, the electric pump can be operated much more economically, owing to the small loss in power in transmitting electricity, as compared with steam at an equal distance.

The electrical system of power distribution in regular work permits of the utilization of water powers situated at distant points, and in the absence of water power, renders a concentration of the steam plants possible.

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[1] Extract from paper read April 29th, 1891, before the N. E. Cotton Manufacturers' Association.

NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS.[1]—I.

BY W. B. ESSON.

PREVENTION OF SPARKING IN MACHINES GENERALLY.

From the data furnished by a large number of examples, some of which were given in the paper which I submitted for your consideration twelve months ago, an expression for the load which could be safely carried by armatures without causing sparking was obtained; this expression, though admittedly of an arbitrary character, having been proved by my own experience and that of my colleagues, to have been of some service. In that paper the term "ampere-turns" was employed to denote the product of the number of conductors on the exterior of the armature and the current carried by each, and I am afraid this may have led to some confusion; at least, so it appears from the discussion. In order that there shall be no misunderstanding in the present case, I shall call this product, quite irrespectively of the number of poles, the *volume* of current carried. The volume is therefore the total current flowing parallel to the armature shaft, independently of direction and whatever the number of poles, and it is obtained by multiplying the conductors on the exterior of the armature by the current flowing in each; or, considering the exterior winding as a copper cylinder, it is the total current flowing in its parallel to the axis.

In his paper on "Armature Reactions," read here last year, Mr. Swinburne had worked out the limiting load from a theoretical point of view, and those who were present will remember that to obtain the results given in his paper the author assumed that the brushes were placed almost close to the polar tips. For the moment, however, it will be assumed that the brushes are somewhere near the pole-tips—in their vicinity, let us say—and that the only conductors concerned in producing the cross field are those covered by the pole-pieces. This is sufficiently near the truth for our purpose. Under these circumstances the magnetizing force in ampere turns producing a cross field is, of course, $\frac{v\,\varphi}{360}$ where v is the volume, and φ the angle embraced by each pole-piece in degrees. Call l the length of the air gap, measured from the surface of the armature core to the polar surface, and I the induction per square centimetre which would be produced in the gap due to the field magnets alone. When a current flows in the armature the field is weakened at the pole-tips nearer the brushes and strengthened at those farther from them. Imagine that the armature is loaded so that the forward induction under the nearer pole-tips is just balanced by the cross induction, and we have $\frac{v\,\varphi}{360} = 2l \times .8\,\mathrm{I}$, assuming that the components of the cross circuit, other than the air gap, have no resistance. According to this equation, with a value $v = \frac{576\,l\,\mathrm{I}}{\varphi}$ the forward and cross induction at the pole-tips would be equal, the field would be *nil* at the brushes, and the machine being unstable, any increase of current would at once cause great sparking.

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[1] Abstract of a paper read before the Institution of Electrical Engineers.

THE RELATION OF *v* TO THE DIAMETER OF THE ARMATURE.

But besides taking care that the armature load does not approach the sparking limit, we must provide ample surface for getting rid of the heat generated in the conductors. The first thing to be settled in designing a new machine is what this amount of heat shall be; or, in other words, we must fix the ratio which the energy appearing at the terminals shall bear to the total electrical energy produced. Having settled this, sufficient radiating surface must be allowed to prevent too great a rise in temperature—a point to which due consideration has already been given.

The principal factors which determine the relation of the volume to the diameter of the armature are efficiency and temperature. To carry a given volume we must have, consistent with the with the waste of power permissible, a certain section of copper; and this copper should be disposed so that a cooling surface is provided sufficient to keep the rise in temperature within the specified limit, while the gap, being of sufficient length to prevent sparking, should have only the dimensions necessary for accomodating the conductors and allowing of proper clearance.

Though the relation lacks definiteness to some extent, I find in the data of a large number of machines, indications sufficiently pronounced to justify us in regarding the volume carried by the armatures of two-pole dynamos as proportional to the diameter for all sizes. In designing cylinder machines the value of v may be taken as 400 times the diameter of the armature in centimetres, while for drum armatures the volume is obtained by multiplying the diameter by 600. The cylinder armature has for a given volume a large diameter, because of the influence of the interior wires. These being heaped inside to one and a half or twice the depth of the exterior winding, also being longer, a larger diameter is required for a given volume, both from efficiency and temperature considerations. Necessarily, the relations here given are not of a hard and fast character, and may be varied considerably. But whatever the proportion adopted, it is absolutely essential that the sparking limit already considered be not too closely approached.

OUTPUT OF DIRECT CURRENT ARMATURES.

If we call N the total number of lines of force entering the armature from all the poles, however many, and n the number of revolutions per second, the average E. M. F. generated in each conductor is, of course, $\mathrm{N}\,n\,10^{-8}$. If C be the total current flowing, each conductor will carry, with the sections coupled in the ordinary way, $\frac{\mathrm{C}}{p}$ amperes, p being the number of poles. The electrical work due to each conductor is $\frac{\mathrm{C}}{p} \times \frac{\mathrm{N}\,n}{10^8}$; and the total work, $\frac{w\,\mathrm{C}}{p} \times \frac{\mathrm{N}\,n}{10^8}$, where w is the number of conductors, counted all round the exterior of the armature. The quantity $\frac{w\,\mathrm{C}}{p}$ is what we have called the *volume*, and we get for the total electrical output, in watts, the expression

$$\mathrm{W} = \mathrm{N}\,n\,v\,10^{-8},$$

which is quite independent of the manner of coupling up the armature sections. It will be evident, I think, that with the same relation existing between v and d for two, four, and six poles, the output of an armature of given diameter and length, running at the same speed, is quite independent of the number of poles. It matters not whether N be furnished by two poles only, or by four poles of half the angular width, provided its value remains unaltered.

The volume, then, may be expressed in terms of the diameter. The quantity N may be expressed in terms of the diameter × length of the armature. Taking an induction of 5,000 C. G. S. units per square centimetre in the air gap—a very usual figure—and assuming that the fraction of the armature circumference covered by the pole-pieces = 2.25 d, we get, calling L the length of the armature in centimetres, 11,250 $d\,L$ as the total number of lines of force entering the core. Call this, in round numbers, 12,000 $d\,L$. Substituting for N and v their values, the output becomes for cylinder armatures

$$\mathrm{W} = .048\, d^2\, Ln$$

and for drum armatures

$$\mathrm{W} = .072\, d^2\, Ln.$$

This applies to all direct current machines, whether bi-polar or multipolar; though it will be understood, of course, that the induction in the gap may be greater or less than what has been assumed. In that case the co-efficients .048 and .072 would be altered, without changing, however, the form of the expression.

SOME POSSIBLE MODIFICATIONS IN THE METHODS OF PROTECTING BUILDINGS FROM LIGHTNING.[1]

BY N. D. C. HODGES.

Ordinarily a lightning-rod is regarded as a conduit or pipe for conveying electricity from a cloud to the ground. The idea is that a certain quantity of electricity has to get to the ground somehow; that if an easy channel is opened for it, the electricity will pass quietly and safely; but that if obstruction is introduced, violence and damage will result. This being the notion of what is required, a stout copper rod, a wide-branching and deep-reaching system of roots to disperse the charge as fast as the rod brings it down, and a supplement of sharp points at a good elevation to tempt the discharge into this attractive thoroughfare, are naturally guaranties of complete security.

I think Oliver J. Lodge has expressed well the difficulty that has always been present in my mind when I have read detailed descriptions of the effects of lightning. He says, in a paper published in THE ELECTRICAL ENGINEER some time last June, that when, in spite of all precautions, accidents still occured; when it was found that from the best-constructed conductors flashes were apt to spit off in a senseless manner to gun-barrels and bell-ropes, and wire fences and water-butts, it was the custom to more or less ridicule and condemn either the proprietor or the erector, or both, and to hint that if only something different had been done, say, for instance, if glass insulators had not been used, or if the rod had not been stapled too tightly into the wall, or if the rope had not been made of standard wires, or if copper had been used instead of iron, or if the finials had been more sharply pointed, or if the earth plate had been more deeply buried, or if the rainfall had not been so small, or if the testing of the conductor for resistance had been more recent, or if the wall to which the rod was fixed had been kept wet,—then the damage would not have happened. Every one of these excuses has been appealed to as an explanation of a failure; but because the easiest thing to abuse has always been the buried earth connection that has come in for the most frequent blame, and has been held responsilbe for every accident not otherwise explicable.

The ordinary theory of the formation of the high potentials that are manifested in lightning-discharges is simply this, That if, in the cloud, there is a certain quantity of electricity distributed on a given mass of fine mist, it will exist there at a certain potential, depending on the capacity of this finely divided matter. Now, if these mist-particles coalesce into raindrops, the thoeory points out that there would be a decrease in potential of the charge. It occurred to me immediately, that, if this theory had any foundation in fact, it ought to be possible to reverse the operation on the surface of the earth; that is, to receive the lightning-discharge on some large body, which would then be broken up into fine particles of vapor, which would have a considerably greater electrical capacity, and that the potential of the discharge would thereby be materially reduced, and the effects of the lightning mitigated. This was my hypothesis to work upon, and I immediately began to look through the records to see what actually happened in the case of lightning discharges, and to see if there was any support in fact for my hypothesis.

The first book at hand was Sir William Thomson's "Papers on Electricity and Magnetism," and I found that he described in detail the case of a farmhouse in Scotland, which was struck by lightning, and in which this very dissipating effect took place; that is, the bell-wires were dissipated,—an occurrence which, as you know, is extremely common when a lightning-discharge takes place. I went on through the records, and found numberless cases of this, the oldest being that of the dissipation of the metal covering on the wooden shield of some Greek warrior. I mention this case as of interest, as it brings out a very fortunate circumstance, that when thin metal is dissipated against wood or even against plaster, no harm results to the wood or plaster. Of course, you know that it has been somewhat discussed whether this action is a dissipation through the heating of the metal, or whether it is a cold dissipation—a breaking-up into particles, as it were—of the metal. On this point I have nothing to say.

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[1] Abstract of a paper read before the American Institute of Electrical Engineers, April 21, 1891.

But as I went on through the records I could not make the facts accord satisfactorily with my hypothesis. The dissipating action that I was looking for certainly took place, and is a very common accompaniment of lightning-discharges, but in spite of it, there was damage to the building. It was only after a considerable reading of the records that it gradually dawned on me that I had found no case where damage to the building occurred on the same level with the dissipated conductor.

The author then described in Franklin's own words a typical case of the action of a small conductor dissipated by the discharge.

I would thus formulate what seems to be true,—that a conductor which can be easily dissipated by a lightning-discharge protects the building to which it is attached between two horizontal planes, the one passing through the upper end of the dissipated conductor, and the other through the lower end; and it is this one point that I would urge upon the consideration of the Institute. So far as I know, therefore, a conductor such as I have here—a conductor made of light copper ribbon, so that 75 feet of it will weigh only a pound, and made in sections two feet long, which shall be tacked to the building from its ridge-pole to the foundation, the joints being made of low conductivity by the insertion of insulating washers—will protect the building. The conductor will be destroyed by the discharge. Its destruction can take place even against a plastered wall without injury to the wall; but no other harm will occur so far as the conductor extends in a vertical direction. There is no need of the conductor following the shortest course to the ground. There is no need of providing a good earth connection. I can see no difference between the two ends of the metallic ribbon. You do not attempt to make a good connection at the top with the dielectric, and I do not see why you should attempt to make a good connection at the bottom. In no case on record of the protecting influence of dissipatable conductors has this protecting influence depended upon there being a good earth connection. Of course, the ribbon should not be boarded over. Free gun-powder burns harmlessly enough, but it causes damage when burned in a confined space; and the dissipation of a conductor presents similar phenomena. It would not do to run such a conductor as I suggest here part way down the building, and then make it turn up again before its final descent to the ground, as in such a case there would probably be a line of disaster from the point where the upward turn began.

In order to destroy a building in whole or in part, it is necessary that work should be done; that is, energy is required. Just before the lightning-discharge takes place, the energy capable of doing the damage which we seek to prevent exists mainly in the column of air extending from the cloud to the earth in some form that makes it capable of appearing as what we call electricity. We will therefore call it electrical energy. What this electrical energy is, it is not necessary for us to consider; but that it exists there can be no doubt, as it manifests itself in the destruction of buildings.

In spite of the best endeavors of those interested, lightning-rods constructed in accordance with Franklin's principle have not furnished satisfactory protection. The reason for this is apparent when it is considered that this electrical energy existing in the atmosphere before the discharge, or, more exactly, in the column of dielectric from the cloud to the earth, reaches its maximum value on the surface of the conductors that chance to be within the column of dielectric; so that the greatest display of energy will be on the surface of the very lightning-rods that were meant to protect, and damage results, as so often proves to be the case. The very existence of such a mass of metal as an old lightning-rod only tends to produce a disastrous dissipation of electrical energy upon its surface,—"to draw down the lightning," as it is so commonly put.

Having cleared our minds, therefore, of any idea of conducting electricity, and keeping clearly in view the fact that in providing protection against lightning we must furnish some means by which the electrical energy may be harmlessly dissipated, it seems clear why it is that the use of sufficient energy to dissipate a pound of copper, leaves not enough to do harm to other objects around. The question naturally arises how much energy there is available. There is stored up in each cubic centimeter of the column of dielectric from the cloud to the earth, just before the lightning-discharge, an amount of electrical energy given by the expression $\frac{1}{8\pi} K E^2$, where K is the specific inductive capacity of the dielectric, E the electromotive intensity, both in electrostatic units. This expression is given on p. 156, Vol. I., second edition, of Maxwell's "Treatise on Electricity and Magnetism." Substituting the values of K and E, and reducing, we find that the amount of energy involved amounts very nearly to one foot-pound for each cubic foot of air. This is, of course, a maximum value.

According to the usually accepted theories of electrical action, this electrical energy is gradually stored up in the column of dielectric from the cloud to the earth, and is distributed in this column with the greatest amount per cubic foot along some central core, this amount not exceeding one foot-pound per cubic foot, and this process can be continued until the stress is so great that the air breaks down, when what we call a discharge of lightning takes place, and the electrical energy disappears, of course only to take on some other form. You may say that the electricity travels from the cloud to the earth, or from the earth to the cloud whichever you please; at any rate, there is an electrical action in a vertical direction, the discharge being supposed vertical. I will ask, however, whether it is not true that the energy involved travels along the equipotential lines; that is, travels in the main horizontally. It seems to me that it shrinks in, as it were from the considerable column or ellipsoid of dielectric upon the central core, where it manifests itself as heat and light in the electrical flash. It will, then, be clear how it is that in providing a body upon which the dissipation of energy shall take place we had to guard against something not coming from above or below, but coming from the side, and that this may be the explanation of why it is that, so far as I have been able to find, a dissipatable conductor protects the building between two essentially plane surfaces passing through its upper and lower ends.

The main point which I would urge upon your consideration is that by giving the electrical energy something which experience shows it would readily dissipate, that is, a conductor of varying resistance and small size, we can but mitigate the effects of lightning-discharges, so long as the conservation of energy holds true. I will only repeat that I have so for found no case on record where the dissipation of such a conductor has failed to protect the building under the conditions already explained.

Letters to the Editor.

RULES AND FORMULÆ FOR INCANDESCENT LAMP WIRING.

In the issue of April 29, I notice some remarks concerning my communication which appeared in the issue of April 15. I will say that Mr. Pike has certainly cleared up the subject in a very simple and practical manner.

I confess that my statement, regarding a theoretically perfect system, should have been given with some reserve.

However, I am glad to be corrected in the matter, and hope next time I will discuss more of the possible instead of the impossible.

OSBORN P. LOOMIS.

BROOKLYN, N. Y, April 29, 1891.

METHOD OF FASTENING BASES TO INCANDESCENT LAMPS.

Will you kindly inform me of a formula for some compound used as a cement to fasten on the bases to incandescent lamp bulbs. Any further information on the same subject would be of value to me.

ALFRED C. TEVIS.

Haverford College, Haverford P. O., Pa.

ANSWER:

Lamp.—The lamp should have either a roughened surface on glass, or glass horns should be melted on when the carbon is sealed in, to insure no movement between bulb and base when finished.

Mould.—The mould is preferably made of brass in two parts; before placing in the rack it should be wiped with oil; then the parts forming the base or sockets should be placed in the mould, being sure that the parts are perfectly free from oil where the plaster comes in contact.

Compound.—Mix plaster of Paris with water to a consistency of cream; then pour into the mould which has been previously prepared.

Method of Handling.—Pull lamp down into the mixture in mould, being sure to separate the wires, and placing them according to form of base used before doing so; keep the bulb in a perfectly vertical position to insure the base being true on lamp; when the plaster has set, take the mould off and place the lamp in a room or oven where the temperature does not exceed 95° F., so that the plaster dries gradually; if dried too quickly it will crack. After being dried for about 20 hours, trim off and white shellac the exposed plaster.

PHILLIPS, ME.—At the annual meeting of the stockholders of the Sandy River Telegraph Co., the following officers were elected: E. J. Gilkey, president; Harry P. Dill, clerk and treasurer; E. J. Gilkey, Wm. Bates, G. D. Austin, Joel Wilbur, D. H. Toothaker, directors. A dividend of $1.25 per share was declared.

Society and Club Notes.

ANNUAL AND GENERAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The Spring meetings of the Institute will be held on May 19th, 20th and 21st, at its headquarters, No. 12 West 31st street, New York city. The preliminary programme as arranged by the Committee on Papers and Meetings, and the Local Committee of Arrangements, is as follows: The regular monthly meeting of the council will be held in the secretary's office at 5 P. M., May 19th.

The annual meeting for the presentation of reports, election of officers, and other business will follow at 8 P. M., on the same date. The morning session, May 20th, will assemble at 10 o'clock, when the following papers will be read:

"The Development of the Dynamo," by Prof. Harris J, Ryan; "Evolution of the Stationary Electric Motor," by Dr. S. S. Wheeler; "Some Data Concerning the Photometry of the Arc Lamp," by Prof. E. L. Nichols.

Afternoon session, May 20th, "A new Graphical Method of Calculating Leads for Wiring," by Carl Hering; "Street Car Motor Design," by H. F. Parshall; "A Proposed Electrical Equipment for the Coming Rapid Transit System of New York City," by Frank J. Sprague.

"Some Recent Improvements In Printing Telegraphs," by H. Van Hoevenbergh, illustrated by diagrams and apparatus in operation.

Evening session at Columbia College. Experiments with "Alternating Currents of High Frequency," by Mr. Nikola Tesla.

Thursday morning, May 21st, the members will meet at the Crocker-Wheeler Motor Co.'s factory, 430 West 14th St. After an inspection of this establishment, the meeting will reassemble at 12 West 31st St., when the following papers will be read:

"A New Device for the Measurement of Alternating Current Potential," by Prof. Geo. S. Moler; "A Study of the Fluctuations of E. M. F. in the Open Coil Armature of a Constant Current Machine," by Mr. M. E. Thompson; "Some Results in the Practical Utilization of Electric Welding," by Dr. F. A. C. Perrine.

Afternoon session, May 21st, "Electric Meters," by G. W. Walker; an address by Dr. W. H. Wahl on "The Aluminum Problem, Retrospective and Prospective," also a paper entitled "Shall Aluminum be Alium?' by Mr. Oberlin Smith. In connection with this subject there will be an exhibit of aluminum products.

Thursday evening a reception will be tendered to the Institute by the Electric Club.

Visits to different electrical establishments and objects of interest will also be arranged for Friday, May 22nd, an announcement of which will be published in the official programme.

MAGNETIC CLUB.

A very successful dinner was given by the above club on Wednesday evening last, at Zanghieri & Succho's restaurant, on Sixth avenue. President Cockey was in the chair. The attendance was very large and enthusiastic. After the dinner, which was excellently served, came a programme of speeches, songs, pianoforte music, recitations, &c. The club is rapidly growing in membership and influence.

NEW YORK ELECTRIC CLUB.

A dinner will be given at the club house on May 5, to celebrate the fifth anniversary of the organization. President Insull has taken up the good work begun with such brilliant success by President Madden, and proposes to lift this year a large portion, if not all, of the club's indebtedness. The recent growth in membership is very gratifying as an augury of renewed life and vigor.

NEW YORK ELECTRICAL SOCIETY.

On Thursday, April 30, Mr. Charles Steinmetz, electrician of the Eickemeyer Dynamo Machine Company, delivered a very interesting lecture on "The Elementary Principles of Designing Alternating Current Apparatus," before the Society at Columbia College. Mr. Steinmetz began by pointing out the fact that the first dynamos constructed for practical use were alternating machines, and that for a long time continuous current machines were only used as exciters for the field magnets of the former. He then described various types of modern alternating machines, and showed the manner in which they resembled the older machines. With continuous current machines, remarked Mr. Steinmetz, all that was formerly required was a knowledge of Ohm's law, and, by means of trials and experiments, tolerably good results were obtained; but the work of Hopkinson and Kapp on the magnetic circuit placed the continuous current machine at once within the realm of prime movers which could be calculated exactly before hand.

The discovery of the converter principle in electricity again brought the alternating machine into prominence; but when it became a question of designing alternating current apparatus, such as converters, generators, and motors, difficulty was at once experienced, because alternating currents do not obey Ohm's law and other laws to which the continuous current is subject. Mr. Steinmetz demonstrated this by taking a coil having half ohm resistance, and placing it in a 50 volt alternating circuit. With a continuous current circuit, a current of 100 amperes would have passed through the coil. The ammeter in circuit showed, however, only 10 amperes. He also showed how the introduction of an iron core within the coil decreased the current passing through it, and explained the difference between the cutting down of the current by a rheostat and by self induction. In the one case the energy is entirely absorbed in the rheostat, which dissipates it so far as useful work is concerned; but when cut down by self induction, the energy is merely retransferred to the circuit which is the source of the energy. Mr. Steinmetz likened the difference in these two cases to the shutting off of light by a mirror and by a black screen, respectively. In the one case, the light, while shut off, is reflected towards the original source and is not diminished. With a black screen, however, the light is absorbed and lost for all purposes of illumination.

Mr. Steinmetz then showed the screening action which takes place when the iron core within the coil is surrounded by a closed coil. The latter then absorbs all the energy and is heated, and the primary inducing coil has no effect on the iron core. This shows that the real field of action is outside of the wire, and that the wire is merely a medium which governs the course of the action.

Mr. Steinmetz then showed that under certain circumstances the sum of the currents in two branches of an alternating circuit is greater than that in the main circuit. For this purpose he coupled up three ammeters, one in the main circuit and one each in the two branches, one of which consisted of an inductive resistance and the other of a non-inductive. The current in the two branches respectively was 9 and 9½ amperes, while that in the main circuit was only 14 amperes. Mr. Steinmetz then showed by very simple diagrams that the instantaneous value of the E. M. F. of an alternating current which follows the law of sines when laid out in polar co-ordinates gave points on a circle. He also demonstrated that a combination of sine waves of different phases follows the law of the parallelogram of forces, and that in general any number of sine waves can be resolved into a polygon of forces. Mr. Steinmetz showed how the various phenomena which enter into the operation of converters and alternating apparatus, such as lag due to hysteresis, Foucault currents and self-induction can be worked out graphically, and he also demonstrated graphically that the E. M. F. of mutual induction consumes energy, while that of self induction entails no loss of energy.

In the discussion which followed, Mr. Mailloux pointed out that while the experiment of the branch circuits apparently showed a greater energy in the branches than that in the main circuit, in reality this was not the case, as the power was the product of the current strength into the potential, and that although the currents indicated were greater, the actual energy was not, and hence that the phenomenon was not at varience with the law of the conservation of energy.

Legal Notes.

EDISON FILAMENT CASE.

It is stated that, contrary to expectation, the Edison filament case will now come up for argument, and that Judge Wallace has decided to hear the argument himself when he comes to New York to hold the Equity Term, beginning May 25. It is said also that the Edison company are desirous to push the case all they can.

OBJECTING TO STATE TAXATION.

The Brush Electric Illuminating Company has procured from Judge Patterson of the New York Supreme Court a writ of certiorari to review the action of State Controller Wemple in levying on it, from 1881 to 1888, a tax amounting to $10,752.50. The tax has been paid, but under protest, the company alleging that it is exempt from State taxation.

College Notes.

UNIVERSITY OF MINNESOTA.

The Minnesota legislature has appropriated $120,000 for extraordinary expenses of the State University. Of this sum $15,000 will be used for the equipment of a school of mines and department of pharmacy. The School of Mines will occupy quarters in Pillsbury Hall and the Engineers' Building. Professors of electrical engineering and of mining engineering will be shortly chosen. Candidates are now being considered by the Executive Committee of the Board of Regents.

Reports of Companies.

THE SENECA FALLS, N. Y. ELECTRIC LIGHT AND POWER STATION.

This station, when completed, will be one of the most solid and substantial for its size in the state. The main shaft, which will be five inches in diameter and over seventy-five feet long, will rest on solid masonry abutments, the foundations of which extend eight or ten feet below ground. To this shaft may be applied direct the force of three 80 h. p. water wheels, one 80 and one 290 h. p. engines, making a total of about 540 h. p. Along on either side of the main shaft will be arranged the dynamos for the different arc light circuits, the incandescent circuit, and the power circuit for the electric railroad, etc. The three water wheels will be controlled by electric governors.

ILLINOIS PULSION TELEPHONE CO.

Under the title of the Illinois Pulsion Telephone Company, a new corporation has just been formed, the incorporators being Carlos J. Ward, Ora Ensminger and W. H. Palmer, of Chicago. The capital stock is $500,000, about three fourths of which is held in Chicago. The organization is for the purpose of building and leasing lines of private telephones throughout Illinois. As the name suggests, the Pulsion, or acoustic, telephone will be used. The State right has been secured from the Pulsion Telephone Company of New Hampshire, owners of the patent. At the present time Boston is the only city in the country which has a similar company.

KEYSTONE ELECTRIC CO.

The above concern, of Erie, Pa., is now a full fledged corporation. It has a capital stock of $25,000, and its officers are :—J. W. Leech, president and general manager ; C. J. Sturgeon, secretary and superintendent ; J. F. Downing, treasurer. The last named gentleman is a wealthy citizen, and the general manager of two large insurance companies. The Keystone motors, etc., will now be actively pushed, and a large business is confidently expected. The company invite correspondence, and are ready to fill orders with the utmost promptitude.

THE TEXAS SALE OF THE ERIE TELEPHONE CO.

The Boston News Bureau says : "It is understood that the arrangement entered into by the Erie Telephone Company with the Texas syndicate, is in substance an option whereby the syndicate has the privilege of buying a portion or all of the stock of the Southwestern Company owned by the Erie. If a sale is made the proceeds will be divided in extra dividends among the stockholders. The terms are a cash payment for all stocks purchased except $50,000 worth, this to be 20 per cent cash, balance at interest, payable in one year, secured by the stock as collateral. The Erie Company reserved during 1890 a cash surplus of $70,000, which, with a loan of $60,000 has enabled the company to take its proportion of the new stock issued in the sub-companies with the American Bell Telephone Company. The company has an underground plant covering the most important streets in St. Paul, Minneapolis and Cleveland, and conduits in the same cities of 2,000 miles of wire. The new stock issued provided for this. A good authority on Erie Telephone says : Judging the earnings of the company by the surplus earnings of the past nine months the Erie Company will add to its surplus for the fiscal year ending March 31, 1891, about $12,000, and the sub-companies $25,000, making a total surplus for the year $37,000. Seventeen thousand dollars of the $25,000 would be Erie's share, which with the $12,000 would make $29,000. At that rate the floating debt of the company, which amounts to $60,000, would soon be wiped out. The sub-companies have no indebtedness and can incur none without violating the American Bell contract."

DETROIT ELECTRICAL WORKS.

The stock of this enterprising company is being traded in very actively on the Boston Stock Exchange, and has seen a rapid advance in price. President Hugh McMillan of the Detroit Electrical Works is quoted as saying that in 1890, on a capital of $200,000, the company earned $50,000. Mr. McMillan has been assured since he left Detroit, that company would have contracts to equip the railways of Fall River and Lawrence, and Buffalo, N. Y., with the Rae motors, and generators. These contracts are figured as making over $1,000,000 business immediately on hand. The Detroit Works are doing practically a cash business, and not promoting companies. Several well-known Boston men will be added to the board of directors.

DIVIDENDS.

SOUTHBRIDGE, MASS.—A semi-annual dividend of 3 per cent. has been declared by the Gas and Electric Light Company.

THE THOMSON-HOUSTON ELECTRIC CO. has declared a dividend of $1 per share, payable May 15.

STOCKS AND BONDS.

WESTINGHOUSE STOCK is steadily rising on reports of a final adjustment of the company's finances, and it has now passed 15.

Appointments, Etc.

MR. ISAAC P. SAMPSON has been reappointed treasurer of the Athol, Mass., Electric Light Co.

MR. JOSEPH SPRAGUE, assistant superintendent of the Carthage, Mo., Electric Power Co., will hereafter have his headquarters in Cartersville, to operate the plant there.

MR. GEO. B. COLEMAN has become electrician, and Mr. A. B. Prince engineer, at the electric light station at Milford, Mass. Mr. A. H. Shaw of the Thomson-Houston electric works has temporarily filled the position.

MR. W. B. BROWN, has resigned his position as electrician of the Alliance Street Railway Co. of Alliance, O., and has accepted an appointment at increased salary with the Mutual Electric Light Co.

MR. F. MASON has been appointed electrician of the Alliance, O., Street Railway Co.

MR. E. F. CARPENTER has resigned as superintendent of the Gardner, Mass. Electric Co., to accept the position of manager of the United Electric Light Co. of Springfield, Mass., to take effect June 1, next.

MR. G. W. HART, superintendent of the Edison Electric Light Co. of Kansas City, and assistant general manager of the Kansas City Electric Light Co. has resigned these positions in order to devote his energies to the Hart & Hegeman Manufacturing Co. which will manufacture special electric light supplies.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

Mr. J. W. Beane, secretary of the association, has made a trip to Montreal to look over the ground for the convention in that city next August. He found the outlook most promising and made a number of arrangements. The central station companies of Canada and the electrical concerns generally are taking a lively interest in the meeting. The exhibit of electrical goods promises to be large.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of May 2, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	82¼	Edison Gen. Elec. Co.	100
American Tele. & Cable	....	Edison Gen. Co. Def'd	....
Contl. & So. Amer	145	Consol'd Elec. Lt. Co	....
Mexican	205	Edison Illu'g Co. N. Y.	76
Com. Cable Co	105	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	39	North Am. Phonograph	..

BOSTON.

	BID.		BID.
Thomson-Houston	47½	Ft. Wayne Co.	13¼
" Pref'd.	25¼	Am. Bell	206
" Series C.	9	Erie	50
" " D.	7½	New England	52
" Int. Co.	....	Mexican	100
Thomson Welding Co.	....	Trop. American	...
Thomson Eu. Welding	55	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BID.
Penna. Telephone	26	U. S. Elec. Lt (Wash.)	[illegible]
Ches. & Pot. Telephone	55	Eck.&Sold. Home Elec. Ry.	5¼
Amer. Graphophone	5¼		

*Ex. Dividend.

PITTSBURGH.

Westinghouse El. Man. Co. .... [illegible]

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 28, 1891.

Accumulators:—

Method of Making Electrodes for Secondary Batteries, H. H. Lloyd, 451,407. Filed Oct. 27, 1890.
Consists in preparing material or materials to constitute the plate, forming the mass in a suitable appliance, and then applying thereto a molten material or materials under a heavy pressure by means of compressed gas or gases to cause the grid or frame to be instantaneously and firmly attached to the plate.

Alarms and Signals:

Electro-Mechanical Gong-Striking Machine, T. F. Gaynor, 451,121. Filed July 25, 1889.
Device for controlling the striking of a gong through the power of a suspended weight or a wound-up spring.

Electric Indicator, J. L. Ricketts, 451,226. Filed Nov. 28, 1890.
An electric annunciator adapted for use in houses, elevators, &c.

Polarized Bell, A. Storer, 451,414. Filed Aug. 7, 1890.
Details of design and construction.

Conductors, Conduits and Insulators:—

Electric Connection, H. J. Brewer, 451,364. Filed Sept. 5, 1890.
Designed to prevent corrosion from moisture or galvanic action at points of contact and especially applicable to battery connections; consists in a conductor terminal in which the wire is surrounded by a sheathing of practically non-corrosive metal, such as tin.

Safety Connection for Electric Conductors, R. H. Gould, 451,377. Filed Sept. 11, 1890.
A safety device intended to obviate danger to life or property by the breaking and falling of a wire between two poles or other supports.

Insulator, R. D. Haines, 451 379. Filed Dec. 12, 1890.
Applicable to the construction of electric conduits; consists in forming a body or core of clay, drying it until it is firm and rigid, then dipping or submerging it in molten glass, or otherwise covering it with glass in a plastic state, and finally annealing the glass plated conduit in a kiln.

Dynamos and Motors:—

Brush Holder for Dynamos, W. LeR. Emmet, 451,177. Filed Sept. 18, 1890.
A device for securing the requisite pressure between the carbon brush and the commutator of a dynamo and providing means for a conveniently adjustable pressure and for maintaining a uniform pressure along the whole face of the brush.

Starting Device for Electric Motors, E. P. Sharpe, 451,212. Filed Dec. 5, 1890.
A rheostatic switch for controlling and graduating the amount of current supplied to a motor.

Armature for Electric Motors and Generators, P. Grant, 451,242. Filed Nov. 28, 1890.
A compound armature-core formed of a number of sections fitting around a shaft and having air spaces between their adjacent edges. It may consist of a number of radial arms, each consisting of a pair of sections with an air space between them.

Regulator for Dynamo Electric Machines, F. Tischendoerfer, 451 312. Filed Dec. 8, 1890.
A method of regulating a dynamo having auxiliary field-magnet poles, consisting in increasing the magnetic effect in the auxiliary field-magnet cores lying next the brushes in the direction of the armature's rotation in sequence and in similarly decreasing said effects in a reverse direction.

Electric Motor, R. Eickemeyer, 451,320. Filed Aug. 28, 1890.
A reciprocating motor. Consists in the combination of a cylindrical shell of magnetic metal, having apertures to receive means for connecting an interior reciprocating element with external mechanism and affording at its inner surface an annular outer pole-face, a field coil or helix enclosed by the shell, and a central core of magnetic metal within the field coil and affording at its outer surface an inner pole face of opposite polarity to that of the outer pole-face.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, J. T. Van Gestel, 451,142 Filed Aug. 29, 1890.
Relates to batteries called "dry batteries." Employs in connection with the positive or carbon electrode a layer or coating of binoxide of manganese or its equivalent applied and united to the surface.

Lamps and Appurtenances:—

Electric Arc Lamp, C. G. Young, 451,101. Filed Jan. 3, 1889.
A lamp designed and constructed to dispense with the tube which in ordinary arc lamps extends upward to provide a protection for a feed rod.

Hanger for Electric Lamps, P. S. Bates, 451,149. Filed Jan. 6, 1891.
A drum and cord arrangement permitting a lamp to be raised or lowered by taking hold of the lamp itself.

Electric Arc Lamp, J. H. R. Ward, 451,189. Filed Dec. 11, 1890.
A toothed rack and pinion feed adapted to be operated with but one magnet.

Electric Arc Lamp, A. G. Waterhouse, 451,250. Filed July 3, 1890.
In addition to the feeding mechanism includes a retarding mechanism provided with a separate clutch to engage the carbon rod and to travel downward with the rod, also a tripping mechanism carried by the retarding mechanism for controlling the position of the clutch.

Insulating Swing Joint, H. P. Drew, 451,300. Filed Jan. 24, 1891.
Provides a connecting joint for gas pipes capable of being turned at various angles and providing electrical insulation in the flexible joint to protect an electric wire running through the pipe where gas and electric light fixtures are mounted together.

Electric Arc Lamp, R. Schefbauer, 451,309. Filed Oct. 3, 1890.
Improvements in the lamp patented to the same inventor Jan. 28, 1890, No 420,311: designed to simplify construction, to bring the mechanism within a smaller space and to render the lamp more sensitive to the varying strength of current.

Measurement:—

Electric Meter, F. K. Irving, 451,125. Filed Oct. 22, 1890.
Records upon a dial, by a pen or pencil, the movement of the core of a solenoid included in the circuit to be measured.

Metallurgical:—

Magnetic Ore Separator, J. P. Conkling, 451,369. Filed Aug. 7, 1889.
Combines with a conveyor, a revolving cylinder consisting of a shell of non-magnetic material, stationary magnets within the cylinder, and pole-pieces adjacent to the surface of the conveyor and made to extend across the conveyor and to connect the various magnets.

Magnetic Ore Separator, J. P. Conkling, 451,370. Filed Sept. 13, 1890.
Employs several sets of electro-magnets rotating with a shaft arranged transversely and above the conveyor, each pole of every magnet having an independent segmental pole-piece forming the arc of a circle and in superficial contact with the internal surface of a non-magnetic cylinder; means are provided for sending current through each of the electro-magnets in a set when presented opposite the conveyor.

Metal Working:

Method of Electric Welding, E. Thomson, 451,345. Filed June 14, 1890.
Particularly applicable to lap-welding and consists in subjecting the parts to be joined to the action of rolls, hammers, dies, or other devices after they have been heated to the proper temperature by an electric current and after the current has been shut off.

Miscellaneous:—

Electric Switch, LeR. S. White, 451,190. Filed Oct. 11, 1890.
Design and construction of a double-pole switch.

Portable Magnetic Riffle, W. C. Edwards, 451,208. Filed Dec. 11, 1890.
Relates to riffles for separating metallic particles from paper pulp, and consists of a series of magnets inclosed in non-magnetic covering and fixed on a base holding the magnet-poles elevated.

System for Electrically Supplying Hot Water for Consumption and Heating Purposes, M. W. Dewey, 451,239. Filed April 5, 1890.
Similar to the invention patented to the same inventor, Feb. 4, 1890, No. 420,641.

Method of and Apparatus for Electrically Supplying Hot Water for Consumption and Heating Purposes, M. W. Dewey, 451,240. Filed April 5, 1890.
Amplification and details of apparatus for carrying out the system shown in No. 451,239 above.

Electric Switch, H. T. Clark, 451,267. Filed Feb. 5, 1891.
A quick acting or "snap" switch.

Electric Switch, H. T. Clark, 451,268. Filed Feb, 25, 1891.
A quick acting or "snap" switch.

Solenoid and Spool Magnet, H. S. Park, 451,308. Filed March 20, 1890.
Designed to provide for increasing the extent of movement of the core of a solenoid.

Electric Switch, H. A. Chase, 451,397. Filed Nov. 2, 1886.
A switch designed for connecting instruments at a main or central office in any desired one of a number of circuits radiating from such office.

Railways and Appliances:—

Electric Railway, R. M. Hunter, 451,154. Filed Mar. 18, 1886.
An arrangement of conductors and circuits for supplying a branch line and a main line from the same source of electrical energy.

Electrically Propelled Car, R. M. Hunter, 451,155. Filed Jan. 3, 1891.
Relates to the mounting and gearing of motors. The motor is journaled upon each axle by journal-bearings rigidly secured to the field-magnets; a supporting frame is hung from the axles through the bearings of the motors and a support is provided between the frame and the motors.

Electric Signal for Railways, U. S. Jackson, 451,157. Filed June 26, 1890.
A system of signals to acquaint the engineer of a train and station officers of the position of trains upon the road.

Trolley, R. MacRae, 451,211. Filed July 24, 1890
Employs three rollers, two above the conductor and one below it.

Tension and Cut-out Device for Electric Railways, B. Jennings, 451,326. Filed Sept. 19, 1890.
Designed to secure a suitable tension of the conducting wire so as to maintain it approximately in a straight line.

Electric Railway, R. M. Hunter, 451.402. Filed Dec. 2, 1890.
Relates particularly to the position of the overhead conductor upon curves, where it deviates from a position midway between the rails to one nearer the inner rail of the curve.

Telephones and Apparatus:—

Telephone Call Box, F. Villiers-Stead and E. R. Hedgman, 451,143. Filed July 28, 1890.
A "nickel-in-the-slot" call box.

Literature.

Les Theories Modernes de l'Electricité. By Oliver J. Lodge. Translated from the English by E. Meylan, Paris, 1891. *Gauthier-Villars et Fils*, 216 pp.; 5½x9 inches. Price $1.60.

Dr. Lodge's work on Modern Views of Electricity is too well-known to require any extended notice at this time. In the version before us the translation has not only done justice to the original in accuracy, but has retained much of Dr. Lodge's happy style of expression which makes his works so readable.

OBITUARY.

JUDGE HENRY SOUTHER, who was a native of Lynn, Mass., died on April 4th, in Fredericksburg, Va., where he has resided for three years. He was 65 years of age. Judge Souther was president and treasurer of the Bridgewood Milling Co. and president of the Electric Light Co. In Erie, Pa., he served two term as corporation judge.

UNDERGROUND WIRES IN PITTSBURGH.

The question of putting the electric wires under-ground, which had been dormant in this city for a long time, writes our Pittsburgh correspondent, was again resurrected a few days ago in the Pittsburgh Council chamber. Two resolutions were offered as ordinances, and both made compulsory to telegraph, telephone and electric light companies to have their wires put underground. The first ordinance provides, that after July 1, 1891, it shall be unlawful for any telephone, telegraph or electric light company to raise, maintain, continue, use, operate or employ in that part of the city, which is known as the "city proper," any pole, overhead wire, overhead cable or device above the surface of the ground by means of which electricity is or has been transmitted, or to keep any such pole or wire now or before that date erected. Each and every pole and wire now in that portion of the city shall be taken down before that date at the cost of the owner. Any pole or poles not removed on that date shall be removed by the officers of the department of public safety, and any company interfering with the department in the removal of these poles shall be fined not less than fifty and not more than one hundred dollars.

The second ordinance relates to underground wires and provides that any company engaged in the electric light, telegraph or telephone business prior to July 1, 1891, and which has complied with the ordinance for the removal of the poles and wires shall have the right to enter on the streets for the purpose of laying the necessary conduits and subways for their wires on these conditions:—A plan of the proposed system shall be submitted to the department of public works, subject to approval before the work is begun; all wires shall be three feet below the surface and close to the curb, and not more than two feet of any street shall be open at one time; the street pavement must be replaced in good condition; the city shall have the right to use the conduits for the wires of the bureau of electricity; the system shall always be under the supervision of the department of public safety, so far as the safety of the public, police and fire apparatus are concerned; reports of the working of the system shall be furnished in detail when requested by the department of public safety. Any violation of this ordinance will be punished the same way as the one above quoted.

The fact that the wires of the electric street car companies are not mentioned at all in the ordinances has given rise to a great deal of discussion among the companies, which are interested in the ordinances. In the meantime, however, the street car companies are congratulating themselves on the favorable discrimination made by the city fathers for their particular benefit.

SAFETY INSULATED WIRE AND CABLE CO.

MR. E. T. Barberie, the electrical engineer and expert, announces that he has become associated with the Safety Insulated Wire & Cable Company of this city, having been appointed Electrical Engineer of its Underground Cable Department. The Safety company is now prepared to undertake the construction of underground electric light, electric power, telegraph and telephone conduits; to equip them with its own cables, and to guarantee the perfect practicability and permanency of its work. The admirable service rendered by this company's cables, since they were first placed underground in New York, over two years ago, has been a source of great gratification to the management and is considered to warrant it in taking this new departure. The company believes that in order to maintain the record which it has made in New York, it must permit its cables to be handled only by its own staff, and to be drawn into such conduits as shall receive the approval of its own engineers. Mr. Barberie has had an experience of many years both on submarine and underground cable construction, first while electrician of the Postal Telegraph Cable Company, and afterwards in the same capacity with the Manhattan Electric Light Company, the construction and testing of whose underground circuits he had supervision of for over a year.

TRUEX & VAIL.

Truex & Vail have moved into their new quarters in the Electrical Exchange building, and are now receiving their friends there. They will represent as before the Accumulator Co., the Electro Dynamic Co., the Walker Electric Co., and act as general sales agents for the Edco dynamos, and motors, Walker meters, switches, etc.

A. B. LAURENCE.

Mr. A. B. Laurence, New York manager for the Shultz Belting Co., of St. Louis, reports sales of the "Electric Dynamo" belt for the Columbia Building, the Central Railroad of New Jersey Building, the Inman steamer, "City of Chicago," the New Haven Steamboat Co., and the Staten Island Light, Heat and Power Co.

TRADE NOTES AND NOVELTIES

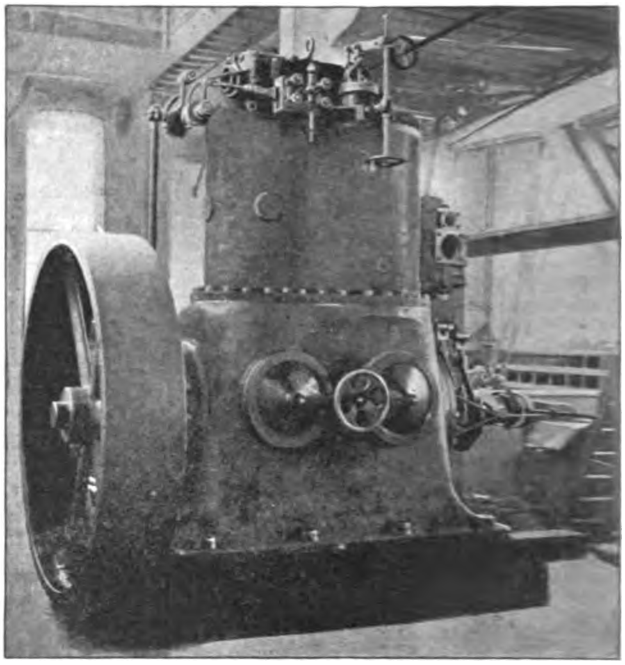
AND MECHANICAL DEPARTMENT.

Don't depend for new business on the advertising you did last year.

A NEW GAS ENGINE.

A new gas engine, designed for use in connection with electric lighting in plants where every foot of floor space is valuable, has just been completed in Pittsburgh. The inventors of this new engine are Mr. Albert Schmid, the superintendent of the Westinghouse Electric and Manufacturing Co., and Mr. Chas. Beckfield.

This is one of the largest gas engines ever constructed, that shown in the accompanying illustration being of 120 h. p. capacity, and was designed and built to take the place of the ordinary steam engine. It has the same movement as the Westinghouse automatic engines and in appearance resembles them very closely. It is claimed, however, to possess a number of advantages over the ordinary steam engine, and to have double its efficiency. It is economical, as it requires no boiler, and takes up little space, and is a great deal safer. In connection with electric lighting plants it will be of especial advantage in large cities, where ground is expensive.



THE SCHMID & BECKFIELD GAS ENGINE.

This engine can be operated with either illuminating gas, fuel gas, or natural gas. Its construction is remarkably simple and without complicated parts.

The inventors are now engaged in the organization of a company, and it is their intention to go into the manufacture of these engines immediately. A plant is to be erected in Pittsburgh as soon as possible. When the factory is in operation the inventors intend to manufacture engines from ¼ h. p. up to 200 h. p.

INTERIOR CONDUIT AND INSULATION CO.

The Interior Conduit and Insulation Company have taken possession of their new suites of offices in the Edison Building at 42 and 44 Broad street. The offices are situated on the fifth floor, fronting on Broad street and on both sides of a private hall, separated from the main passageway by an artistic gate. The several rooms are large, well ventilated, and have an abundance of light from all sides throughout the day. The two large rooms in front are occupied respectively by Mr. E. H. Johnson, president, and Mr. E. W. Little, general manager, and are furnished simply but substantially in hard wood. Mr. E. T. Greenfield, the company's electrician, has his office, draughting and show rooms directly back of Mr. Johnson's office, Mr. F. A. Mason, with the financial department, adjoining. All the conveniences usually found in a suit of well-appointed offices go to make fitting headquarters for such a progressive company.

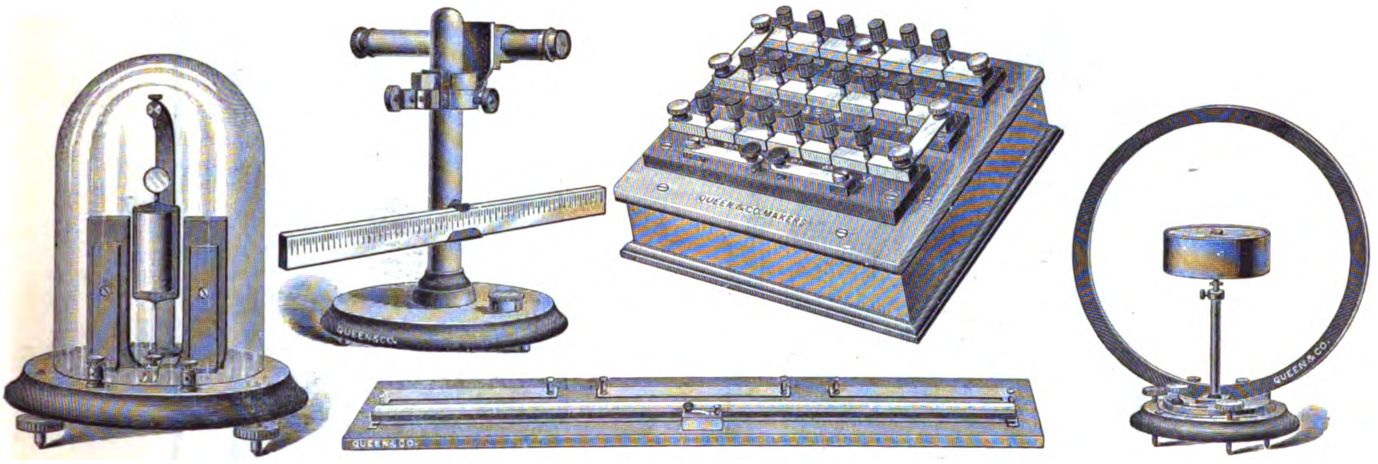
THE RUSSELL DISC ARC LAMPS.

Much time has been spent by the Russell Electric Company, in perfecting their disc arc lamp described in another page, and with the machinery now employed they are thoroughly equipped to turn out lamps with all the parts interchangeable. The factory of the company is situated at Ballardvale, Mass., and the offices at 85 Water street, Boston. Mr. A. W. Rounds is the president of the company, and Mr. F. H. Carpenter, treasurer; Mr. H. E. Chapman is in charge of the factory, and Mr. Hector Dewar is electrician .The company are now ready to supply lamps at short notice, and invite a thorough inspection of the lamp.

SCHOOL ELECTRICAL APPARATUS OF JAMES W. QUEEN & CO.

Last week we illustrated some of the new electrical apparatus of James W. Queen & Co., of Philadelphia, for schools. A few more pieces are shown herewith.

The well known Deprez-D'Arsonval Galvanometer, as it is commonly called, is shown in Fig. 1. This galvanometer, one of the most sensitive types known and very "dead beat," needs no explanation or comment. Fig. 2, is a tangent and sine galvanometer. Fig. 3, is one of the four or five resistance boxes of this series, and represents the type; the particular box shown is a combination Wheatstone bridge and resistance set, having 12 coils in the resistance portion aggregating 1,110 ohms, and bridge arms of 10, 100 and 1,000 ohms on a side, thus giving a range of measurment from $\frac{1}{100}$ ohm to 111,000 ohms; the coils in these sets are all guaranteed to $\frac{1}{8}$ of 1 per cent. A slide wire bridge is shown in Fig. 4.


QUEEN & CO.
QUEEN & CO. MAKERS
QUEEN & CO.
QUEEN & CO.

FIGS. 1, 2, 3, 4 AND 5.—NEW SCHOOL APPARATUS OF JAMES W. QUEEN & CO.

There is also a reading telescope. Fig.5, for use with the previously mentioned reflecting galvanometers. This telescope has adjustments for altitude, and both course and fine adjustments for azimuth. For those not partial to telescope methods, a neat lamp stand and scale is provided. Keys of all descriptions, some of which are illustrated, are included also. The list is completed by speed counters, standard cells, chloride of silver test batteries, small ammeters and voltments, copper voltameters, etc.

SAMSON ARC LIGHT CORD.

The cord used for hanging arc lamps is a comparatively small item in the supply account of a central station, but is quite an important one. Where serious injury to so complicated a mechanism as an arc lamp, as well as grave danger to the public is concerned, it is well to give the subject serious consideration; and from an economical standpoint as well, it is of great importance that sizes and grades of cord should be adapted to the service rendered. A cord that is overloaded will not wear nearly as long as one that is not. Solid braided cords are now coming into general use for this purpose, and the Samson cordage works of Boston, who are the pioneers in this line, have found from long experience that cotton is the most durable material for all outdoor service, and that when waterproofed this cord will outwear all others. Their process of waterproofing, besides protecting the cord from the action of the weather, prevents abrasion in running over the pulleys. The company will be glad to answer any inquiries as to sizes and grades of cord adaptable to varying circumstances.

EVANS FRICTION CONE.

The Washburn & Moen Mfg. Co., of Worcester, are to have in their immense wire factory which they are building in Chicago, one room which will contain two lines of the Evans friction cone pulleys of 75 h. p. each. Each line will contain twelve sets of 6 h. p. cones, with the driving cones coupled together, making two continuous lines of 75 h. p. each. Each set of cone pulleys gives a variation of from one to nine. The speed can be changed or any cone can be stopped while the main line is running.

"ELECTRIC POWER."

The offices of *Electric Power* have been removed from 132 Nassau street to rooms 527, 528 and 530 Electrical Exchange building, 136 Liberty street.

THE UNIVERSAL ARC LAMP COMPANY.

MR. E, S. MENDELS having resigned his position as General Manager of the above Company, Mr. F. W. McClement has been appointed as Acting General Manager until further notice.

THE FITCHBURG STEAM ENGINE CO.

The Fitchburg Steam Engine Co., Fitchburg, Mass., have just closed contract for the engines, shafting, etc., for the W. C. T. U. Temple in Chicago; are also building a large compound engine for the Arnold Print Works, North Adams; large compound for the Brattleboro (Vt.) Gas Light Co.; are shipping complete outfit, including large engine, boilers, etc., for a brass plant in Virginia; are building an engine for the morocco factory of Paschall, Lichten & Lyon, Frankford, Pa.; also large engine for Barnes & Beyer, Phila.; are putting in engine for the Tubular Rivet Co., Wollaston Hights, Mass.; are building engine for the Sockanosset School for boys, Howard, R. I.; also large engine for the Revere Rubber Co., Boston; also engine for Three Rivers Paper Co., Mich.; also large engine for Chicago, and a great many smaller ones. They have just issued a new catalogue, containing full information of our different styles of engines which they will be pleased to send upon application.

THE "CENTRAL ELECTRIC" CATALOGUE.

We had occasion recently to comment on the excellent new catalogue issued by the Central Electric Co. It has elicited some well deserved eulogiums, of which the subjoined is a sample :—

WATERLOO ELECTRIC COMPANY.

WATERLOO, IOWA, April 27, 1891.

CENTRAL ELECTRIC CO., CHICAGO.

Dear Sirs:—We are just in receipt of your new catalogue of electrical supplies. Please accept our thanks for same.

It is without doubt the finest and fullest catalogue sent out by any firm in the United States, if not in the whole world.

Hoping to be able to get even with you for kindnesses in the past, we are,

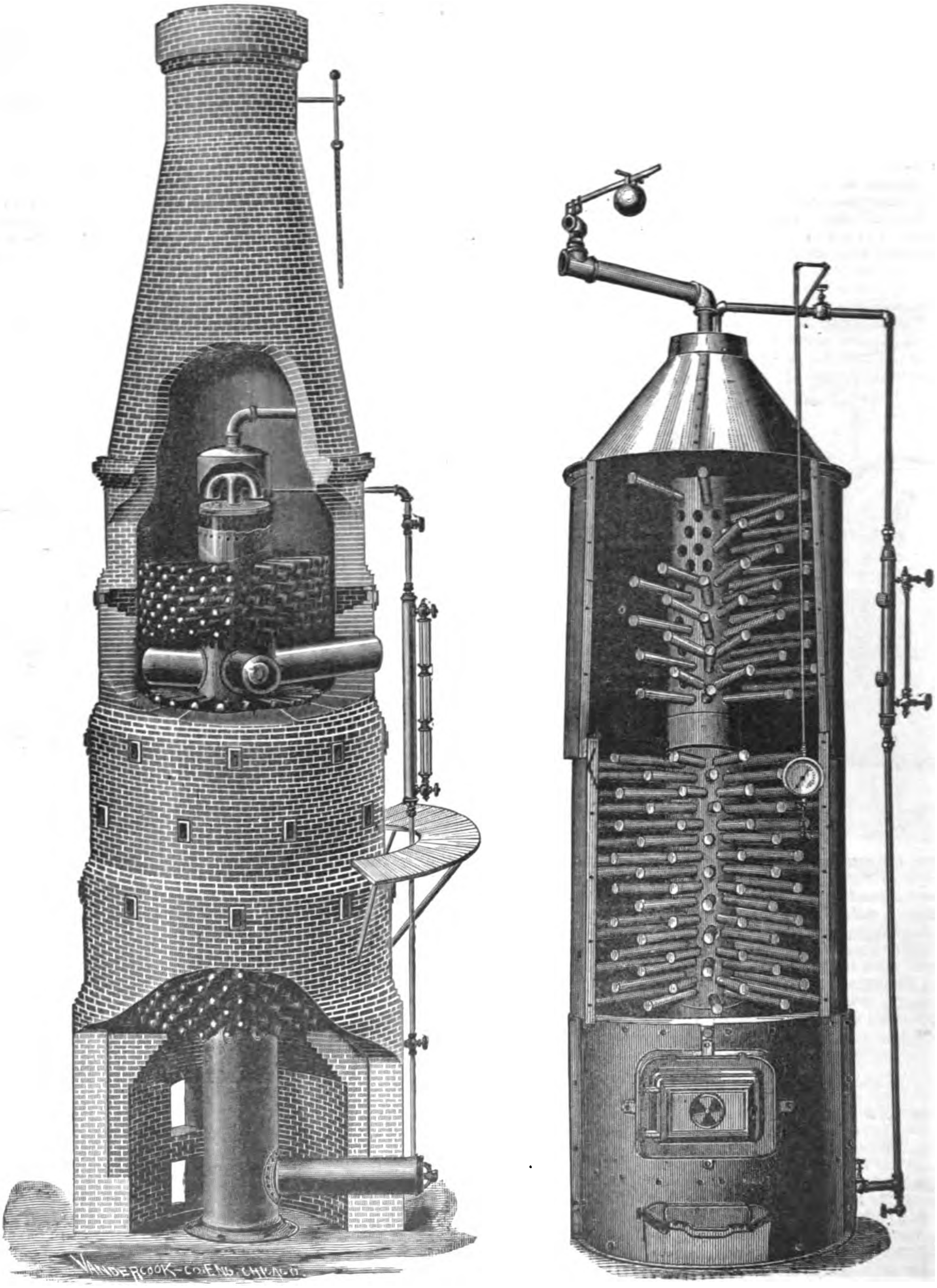
Very truly yours,

WATERLOO ELECTRIC CO

MR. J. LENLON, president of the Ravenna, O., gas and electric light company, recently died suddenly of heart trouble.

THE HAZLETON TRIPOD BOILER AND FEED-WATER PURIFIER.

The accompanying illustrations represent the Hazelton tripod boiler and purifier, manufactured and built by the Hazelton Tripod Boiler Co., 170 Twenty-second street, Chicago. Figs. 1 and 2 show the boiler. Its centre column being upright, the sediment falls to the bottom by gravity, where it is easily removed. The entire boiler acts as heating surface, and the full heat of the fuel is applied most effectually. The part of the boiler above the water line is steam space, the tubes above the water-line acting as dryers. The steam thus leaves the boiler at a higher temperature than that due to the pressure. The gain from this alone is considerable, as it admits of a shorter cut-off owing to the greater expansive power of dry steam. All parts of the boiler are easily accessible for repairs and cleaning. The ground space required is very small, a five hundred horse power boiler only occupying a circle seventeen feet in diameter, and no other stack is required than the brick work of the boiler itself. This brick work may be replaced by an iron jacket with provision for a fire-clay lining in the fire-box.



Figs. 1 and 2.—Hazleton Tripod Boiler.

These boilers are built so that they can be boxed up for mule back transportation, no box weighing more than 250 lbs., and are being extensively used in mountainous regions difficult of access, for mining and prospecting purposes. They are now in use in the Rocky Mountains, Mexico, Central and South America.

Either wood or coal can be used for fuel. These portable boilers are built in sizes from five to thirty-five horse power.

The Hazelton purifier is shown in Fig. 3. It heats the water to the same temperature as that in the boiler. With 80 pounds boiler pressure the temperature in the purifier will be 314 degrees Fahr. The temperature necessary to precipitate the lime held in solution is 302 degrees Fahr. The water inlet pipe (top cylinder) is from a heater of any kind; from this cylinder the feed water flows by gravity to the boiler, as the purifier is under boiler pressure.

The coke in the two cylinders takes up the lime and will retain 95 per cent. of all the solids held in solution.

The vacuum heater uses steam from the pumps, and only a portion of the exhaust from the engine sufficient to raise the temperature of the feed water to the boiling point. Thus the rest of the main exhaust is available for heating purposes and is valuable, being at high temperature. The steam entering the heater, being condensed, returns to the boiler pure water, amounting to about 20 per cent. of that used. The heater contains no tubes, and, it is claimed, will last 35 years.

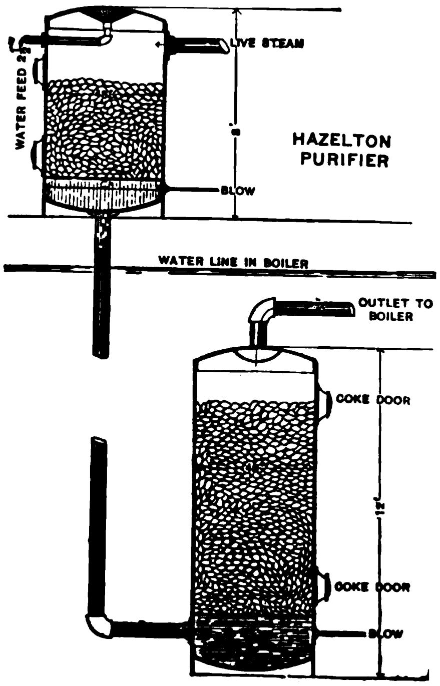


FIG. 3.—HAZLETON FEED-WATER PURIFIER.

The water enters at the top, and falling 6 to 14 feet, according to the size, through exhaust steam, is instantly heated and passes out from the lower end by gravity to the pump, and thence through the purifier to the boiler.

CHAS. A. SCHIEREN & CO.,

The following is a letter received by the above concern from The Home Electric Co., of Seattle, Wash., one of the largest companies in the Northwest:—

"We have two of your Perforated Electric Belts running, one of them has been in use about thirty days, and the other has been running two weeks; they run beautifully, and are very satisfactory. You may refer other parties to us if you choose, and rely on their receiving a very favorable impression of the value of your Perforated Belts.

Yours truly,

HOME ELECTRIC CO.

BY E. C. KILBOURNE."

THE WEEMS ELECTRIC RAILWAS SYSTEM.

The Electro-Automatic Transit Company of Baltimore, Md., has sold its right, title, and interest to the Weems Electric Railway System, a new company organized in New York to develop railroad transit by electricity. The Weems Electric Railway System has been organized with a capital of $2,500,000, divided into shares of $100 each. The officers are: O. J. Smith, president; David G. Weems, vice-president and general manager; Wayne B. Stowe, secretary; John H. Grant, treasurer; A. de R. Sappington, counsel. The general offices of the company are at 32 and 34 Vesey street, New York. The engineering department still continues at 6 South street, Baltimore, the office of the old Baltimore company, with David G. Weems in charge.

In speaking of the removal of the company to New York, Mr. Weems said it was because a larger amount of capital and a greater interest could be secured there for putting his invention into practical operation. The difficulty in Baltimore was in getting practical men to devote sufficient time to push the scheme to the conclusion desired. Those who took stock in the concern, while subscribing liberally and having faith in the ultimate success of the motor, were men whose other business interests were large, and demanded all their time. The New York company has been organized, he said, with ample working capital, and has therefore absorbed the Baltimore concern. Factories for the manufacture of the motors and the cars to be used by the new system will be erected, and the work pushed with all rapidity. It will be remembered that with the Weems system, a speed of 125 miles an hour has been reached on the experimental track at Laurel, Md.

THE NEW AMERICAN TURBINE.

AMONG the many turbine wheels now on the market, few have had as great a share of popularity as the New American, manufactured by the Dayton Globe Iron Works Co., Dayton, Ohio. The New American is not, strictly speaking, a new piece of mechanism; it is the outcome of the American which was first put on the market in 1859. It has been designed specially with a view to strength and durability and will stand the strain of any head; at Niagara Falls, the Cataract Milling Co. has a 25 foot wheel giving 525 h. p., while another one in the same neighborhood, running under 100 feet head, is giving 2,000 h. p. They run with the same steadiness under all heads, are under the greatest control, and are perfectly susceptible to the governor—points which are invaluable features of water wheels.

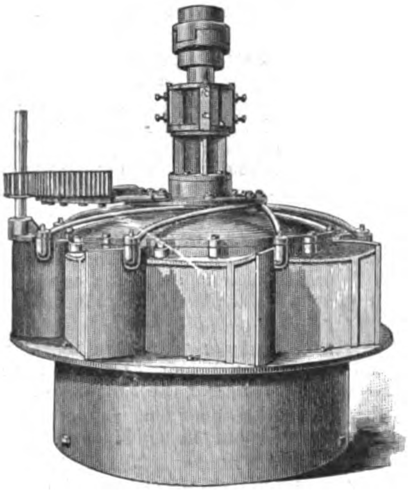


FIG. 1.—NEW AMERICAN TURBINE.

In a fully illustrated catalogue which can be had from this concern, those interested in such matters can find many full descriptions of the manufacture of the New American, its efficiency under different heads, cuts of the wheel and its various parts, of methods used in setting them, and a multitude of descriptions and prints of practical use to any one contemplating the purchase of a turbine. The volume likewise embraces many valuable tables of rules.

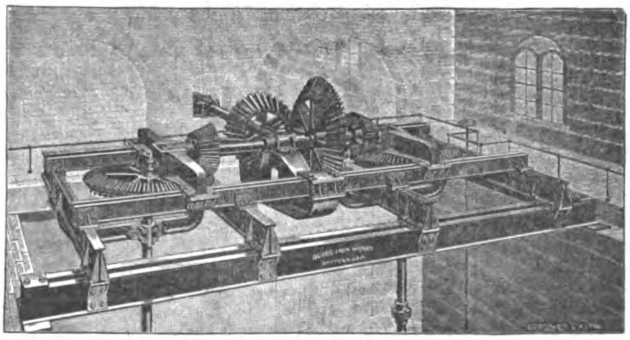


FIG. 2.—GEARING OF WATER POWER PLANT.

In the accompanying illustrations, Fig. 1, shows the wheel itself, while Fig. 2, is a view of the gearing in a large water power plant at Eau Claire, Wis. The wheel is mounted on an iron bed, and can be fitted with additional draft tube, or the inlet may be placed at any convenient angle.

THE BALL ENGINE CO.

The following important circular has been issued by the Ball Engine Co., of Erie, Pa.:

"We take pleasure in announcing to our friends that on and after May 6th, 1891, we will be represented in New York by Messrs. E. T. Copeland & Co., 106 Liberty street. Mr. Copeland's long experience in the sale of engines in New York gives us assurance that our interests will be in intelligent hands.

"We wish also to announce that, owing to the great increase of our business, we are erecting a large addition to our works, which will be equipped with special tools, ensuring perfect construction of our engines. Every engine is fully tested under steam and load before leaving the shop, and every part of the work is thoroughly inspected.

"We are prepared to furnish promptly simple, tandem compound, cross compound and triple expansion engines, up to 500 h. p."

WESTERN TRADE NOTES.

Mr. Frederick Sargent, the electrical engineer of the construction department of the World's Fair, is very busy working out the engineering details of the electrical portion of the Fair. The selection of Mr. Sargent for this position was a most excellent one, as he has had a very wide and diversified experience in electrical engineering and is one of the most capable and energetic men in the profession.

Mr. M. E. Baird, the general agent of the Eddy Electric Motor Co., was a visitor to Chicago last week.

The Knapp Electrical Works are enjoying a brisk run on their electrical supplies. Mr. Myron A. Knapp has just taken the general Western agency of the Safety Insulated Wire and Cable Company, of New York. The Safety seamless rubber wires are well-known, and in such hands the demand for them in the West will be ever on the increase.

The Northwestern Electrical Specialty Co., 1,017 Chamber of Commerce Building, Chicago, are finding a ready sale for the "Economic" incandescent lamp, for which they are the general Western agents. Mr. Geo. L. Kirkham is the manager of the company.

Mr. E. S. Bowen has just completed the work on the complete steam plant for the new south side Edison station, which Mr. Frederick Sargent is installing for the Edison Co.

The Stationary Engineer has now moved its offices to new and handsome quarters at room 24, the Mallers Building.

The Illinois Electric Material Co., 158 Fifth avenue, report their trade in the famous Bishop wires and cables to be very active and increasing largely. Canvas Jacket line wire and Electrix specialties, especially the switches and sockets, are in extensive demand. The wisdom of their recent move to larger and more commodious quarters is now clearly shown by the amount of trade done in the handsome new store, and they have done well "to get in on the ground floor." From the inquiries they have for poles and line supplies they predict a very large and extensive trade for the year, and their present orders substantiate their views.

The Sunbeam Incandescent Lamp Co. are meeting with the most signal success in the introduction of the Sunbeam lamp. Although this lamp has been on the market for but a little more than a year they estimate that there are now some 125,000 in daily use. This is a striking testimonial to the economy of the lamps and the general satisfaction that they are giving.

Mr. A. C. Robbins, well-known amongst the telegraphic fraternity in the East, who has been spending some weeks here, has left for Portland, Ore. He expresses himself as delighted with his short sojourn here, and the many courtesies extended him by the electrical people of Chicago.

"**The Gem**"—The incandescent lamp manufactured by the Thwing Electric Company, of Chicago, has been felicitously named "The Gem." This is highly appropriate and before long, no doubt, we shall see the Gems all over the country.

The Street Railway Gazette people have abandoned the offices they have so long held in the Lakeside building, and found a larger home for themselves in the Mallers building, and as of yore, Messrs. Munroe & Cavell will be found full of information and courtesy at their new quarters.

The Electrical Talent of 331 The Rookery, comprising Mr. Geo. S. Searing, of The National Electrical Mfg Company, of New York, Mr. G. A. Edward Kohler, of the Eddy Electric Motor Co., and Mr. Thos. G. Grier, of the National Engineering Bureau, having found their genius too much cabined and confined in their old quarters, have removed to larger rooms in 339-341 The Rookery.

Mr. James Mitchell, formerly chief engineer for the Pacific slope district of the Thomson-Houston railway department, has been recalled to go immediately to Brazil to install a large street railway plant there.

The Central Electric Co. report large sales on the Packard incandescent lamp. They find that the lamp is very well received by users, and is considered by everybody one of the very best incandescent lamps ever made.

The Okonite Base Ball Club, consisting of the employees of the Central Electric Co., are whitening up their belts and getting in trim for the summer's campaign. They have already secured a diamond in Jackson Park, near the World's Fair grounds, for Saturday afternoons in July and August and will then be ready to meet all comers. This club covered itself with glory in the memorable contest with the Kerite Club, and we expect to see some very brilliant work from it the coming summer with the Hittites.

Cutter's Lamp-Supporting Pulley is having a steady sale in the West, where many of the new arc light plants will use it exclusively. Others are substituting it for the covered or open pulleys now in general use. The need of both a lamp support and a sleet-proof pulley is making itself felt, hence it is not surprising that a pulley which combines these features should sell well.

NEW YORK TRADE NOTES.

Okonite.—Among the recent additions made by Mr. Richard Varley, Jr., chief electrician of the Okonite Company, in their Passaic factory, is a new Thomson quadrant electrometer. Mr. Varley is to be congratulated upon having one of the most thoroughly equipped testing laboratories in the country. Mr. Varley has recently invented a system of locating very minute faults in insulated wire. The instrument is perfectly automatic; no electrician being required to manipulate it. In the short space of 30 seconds a fault having a resistance as high as 2.5 megohms can be located to a fraction of an inch; and in many cases after a fault has been located, the imperfection in the insulation is so minute that the eye can hardly detect it.

Stanley & Hall, 32-34 Frankfort street, this city, have added to their line of electrical house fittings, speaking tubes and all apparatus for thoroughly equipping a building with this line. Their business has grown so steadily that they have found it necessary to add two floors to their old quarters. Everybody who crosses the big bridge is familiar with their modest three-story sign.

The Phœnix Glass Co., 729 Broadway, this city, have new designs in shades for electrical purposes. This company has a most complete line of this class of goods, and a purchaser who cannot find a design among their collection to please him, would be very difficult to please.

McCreary Electrical Specialty Co. have removed from 18 Cortlandt street to the Electrical Exchange Building, where Mr. McCreary will be glad to meet all his old friends and customers.

C. S. Van Nuis, of "Ajax" switch fame, has joined in the procession and removed from his old quarters at 74 Cortlandt street to the Electrical Exchange Building.

NEW ENGLAND TRADE NOTES.

The Electrical Supply Co., of Ansonia, Conn., have decided to enlarge their factory to double its present capacity. Their fine business grows remarkably, and no small portion of it is due to the brilliant success of the western branch under Mr. F. S. Terry.

The Redding Electric Co., of Boston, have made a re-appointment of their officers, and are preparing for a large increase of their business during the coming season. Mr. Harvey Redding is president of the company, James Redding general manager, H. M. Nicholls secretary, and H. P. Stanwood treasurer. Mr. Stanwood is a member of the firm of Converse, Stanwood & Company of Boston, and will use every endeavor to push the firm to the front in the general electric supply business. The company have some important specialties in watchman's time clocks and fire alarm systems, batteries, etc., and will secure new agencies for specialties.

The Wainwright Manufacturing Co., of Massachusetts, have just sold the following heaters and condensers to electric companies:—Two 120 horse-power surface condensers to the North Hudson County Railway Co., Hoboken, N. J.; one 125 horse-power feed water heater to the National Electric Light Company, Eau Claire, Wis.; one 150 horse-power feed water heater to the Pleasant Valley Coal Company, Salt Lake City, Utah for their electric plant.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. MAY 13, 1891. No. 158.

THE PATTEN IMPROVED ALTERNATING CURRENT MOTORS.

BY

F. Jarvis Patten.

THE writer has recently designed and put into operation with the most encouraging results, two novel types of alternating current motors, a machine of each type weighing less than 100 lbs., having developed considerably more than a horse-power without bad sparking or heating when connected in the secondary of a converter circuit.

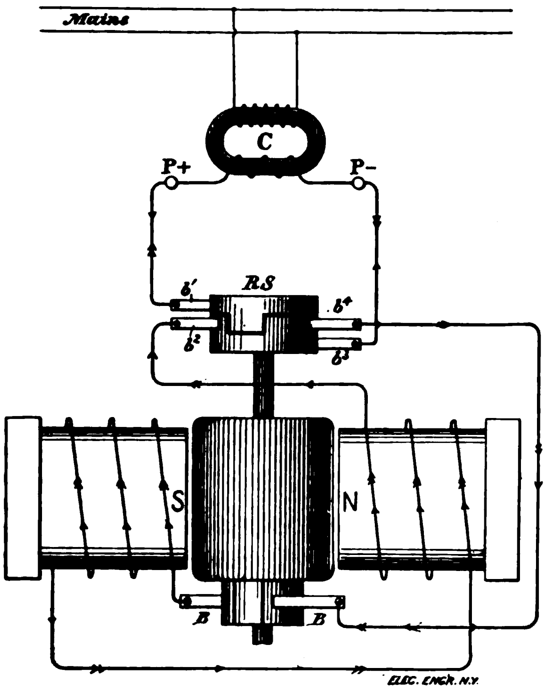


FIG. 1.—PATTEN ALTERNATING MOTOR.

In the accompanying diagrams which illustrate the two methods, the main leads of an alternating current circuit supply the converter C, and P + and P — in each figure are the terminals of the secondary circuit, to which in both cases the machine circuits are connected by means of brushes that bear upon a revolving switch R S which is carried by the armature spindle. In both methods, an ordinary direct current machine, preferably of the Gramme type is used, the windings of field and armature being modified to suit alternating current work, and the cores of both well laminated.

It is of course understood that such machines are self-starters, even when supplied with alternating currents; the fields and armatures being simultaneously reversed, the tendency to rotation is always in the same direction.

The revolving switch in Fig. 1, is composed of two continuous rings notched or halved into each other as shown. Brushes b^1 and b^3 connected to the secondary terminals P + and P —, bear upon these rings. Two other brushes b^2 and b^4, fixed in position, bear upon the middle or segmental portion of the revolving switch, and to these brushes the terminals of the machine are connected as shown.

When current is switched on, the armature begins to revolve under the action of an alternating current, the field and armature simultaneously reversing; but as the armature gains in speed, and the switch is turned faster and faster, it tends more and more to rectify the alternating current that is thus fed to the machine, until at a certain predetermined speed, which is, of course, the normal speed of the machine, and which may be either synchronous with the dynamo, or any multiple or sub-multiple thereof, the revolving switch will operate to completely rectify the current for the machine so that it will be practically fed at this speed by a pulsating direct current. Of course, at this speed the machine will give its greatest output, and there will be a tendency to hold this speed up to the maximum load; there will be no reversals of field or armature polarity, little sparking, and no appreciable heating.

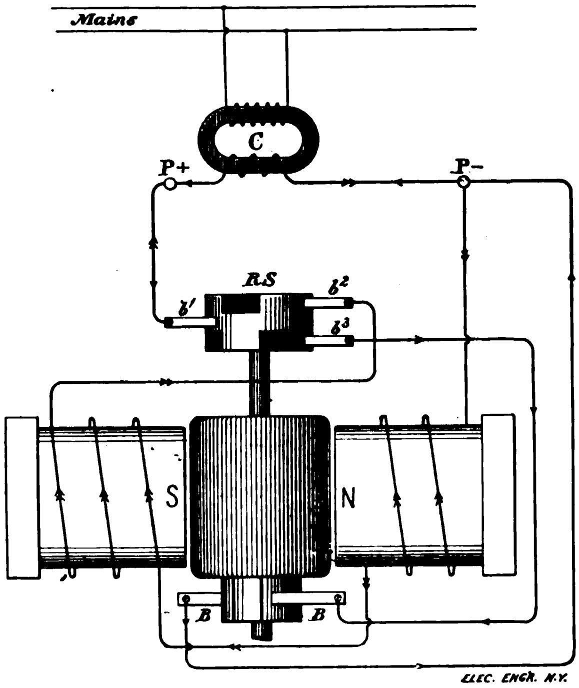


FIG. 2.—PATTEN ALTERNATING MOTOR.

Evidently the motor circuits, field and armature, may be arranged in parallel, which is the preferable way; they are shown in series merely for simplicity.

In the position of the brushes and switch shown in Fig. 1, the machine is shown taking a positive impulse of current from the left hand pole P + of the converter; evidently, if during this impulse the switch turns through the arc covered by one segment, then, when the negative impulse comes, the brush b^4 will bear on the next segment connected to the lower ring, brush b^3 and pole P —, of the secondary circuit, and current coming now from this pole will go through the machine in the same direction as before, as indicated by the double arrows.

Fig. 2 shows a different diagram of circuits by which very good results are obtained with one brush less. A different kind of switch is used, having a continuous ring at its middle portion, and alternate connected and disconnected segments on each side, arranged so that the connected segments on one side are opposite the disconnected segments on the other.

The brush b^1 bearing on the ring is connected to the pole P + of the converter secondary, and the armature of the machine is connected in a circuit from the brush b^2 to the other pole P — of the converter. The field circuit of the machine has one terminal connected to the brush b^3 and the other also to the pole P — of the converter.

The brushes b^2 and b^3 are fixed in position in such a way that one of them, say b^2, bears on a segment connected to the ring, while the other, b^3, bears on a disconnected segment. Of course, as the switch revolves, the field and armature circuits will be alternately connected in the converter circuit.

Then again there is an evident tendency to synchronism or a multiple thereof, and when this speed is reached the armature will take, say, all the positive impulses, and the field all the negative impulses of current, so that each will be supplied with an intermittent current of one direction and the polarities of armature and field will remain constant. As the impulses come to each in turn at about 115 times a second, it is sufficient to maintain a constant magnetization of both, and the machine will work as an ordinary direct current machine.

Of course, this machine, connected as shown in Fig. 2, will not start itself, because only one part, say, the armature, will receive current, while the armature stands still and its polarity will be reversing.

To make this machine self starting, both field and armature are switched temporarily into the same circuit, the machine will then start itself, and after it gets up to speed the field is switched into its proper circuit.

A CHART OF STANDARD ELECTRICAL DIAGRAMS AND SYMBOLS.

BY

Francis B. Crocker

ELECTRICAL engineers, students, draughtsmen and others engaged in electrical work frequently have occasion to make use of, or to interpret, electrical diagrams and symbols, and it is very difficult to find them when they are needed. There is also apt to be some doubt as to the correctness and authority of any particular drawing or sign. I have therefore collected the most important and standard electrical diagrams and symbols, and put them in the form of a chart for easy reference. Of course, it is impossible to make such a chart perfectly complete, but it has been attempted to represent all the most typical of the various kinds of apparatus, systems and facts which are found in electrical engineering, beginning with the simplest and passing to the more complicated.

The chart is also intended as a basis for a course of instruction in electrical draughting in technical schools and offices, there being no rules, guides or models to follow at the present time.

A few moments' inspection will enable one to find and understand any particular diagram or sign, and therefore no explanation of the chart is needed.

OIL AS AN INSULATOR FOR HIGH POTENTIALS.—III.

BY

Daniel Brooks

IN nearly all the text books published up to within a few years, oils were put down as conductors, and John T. Sprague in his edition of 1884, classes them as conductors "in the order of their specific gravity."

My first patent for the use of oil was issued in December, 1878. About that time, I stretched a mile of wire insulated with oil in the yard of my factory; the oil was placed in the glass bottles of my insulators, turned upside down and protected by a cover from rain drops. I could get no current with a battery of 200 cells during rain, between the wire and the earth, a distance, say, of 10 feet; but in a clear warm day a slight deflection was obtained, because all insulating substances show conduction as the temperature is raised; more than 10 times as much when the temperature is at 100° Fahrenheit, than at 32°.

Now we have to consider the conductivity of air as compared with other insulators when higher voltages are used. Mr. C. E. L. Brown states that "for conveying extremely high tension current, only the overhead system can be practically considered, and it is possible to construct an overhead line in such a manner that even with the highest voltages there will be practically no leakage." Perhaps in time he may think otherwise. Mr. August Schneller, of The Hague, Holland, states that he considers the transmission of high tension currents between Lauffen and Frankfort a "technical impossibility." He speaks of a tension of 30,000 volts. In THE ELECTRICAL ENGINEER of April 15th, Mr. Charles Steinmetz, criticizes Mr. Schneller's article with some very sensible suggestions.

Now, going back to the "Electrical Pousse-Café" experiment, last June it was performed at Gloucester, N. J., and, instead of using a small wire immersed in a glass jar of oil, we used two No. 0 conductors drawn into 20 feet of iron pipe. There were about 21 feet of each of the conductors twisted together, and the pipe filled with oil. The conductors were so covered with cotton as to be separated three-eighths of an inch. We tried to puncture the insulation with a Holtz machine, using two leads of rubber-covered wire, each six feet in length. The machine by itself would spark five inches, but when the poles were connected to the two conductors, they would spark only about an inch between the two spheres, the tension being so much reduced by leakage. There was brush discharge between the two rubber-covered wires, and thin blue sparks passed through the dielectric without destroying it. I refer to the rubber-covered leads which were separated from each other about six inches.

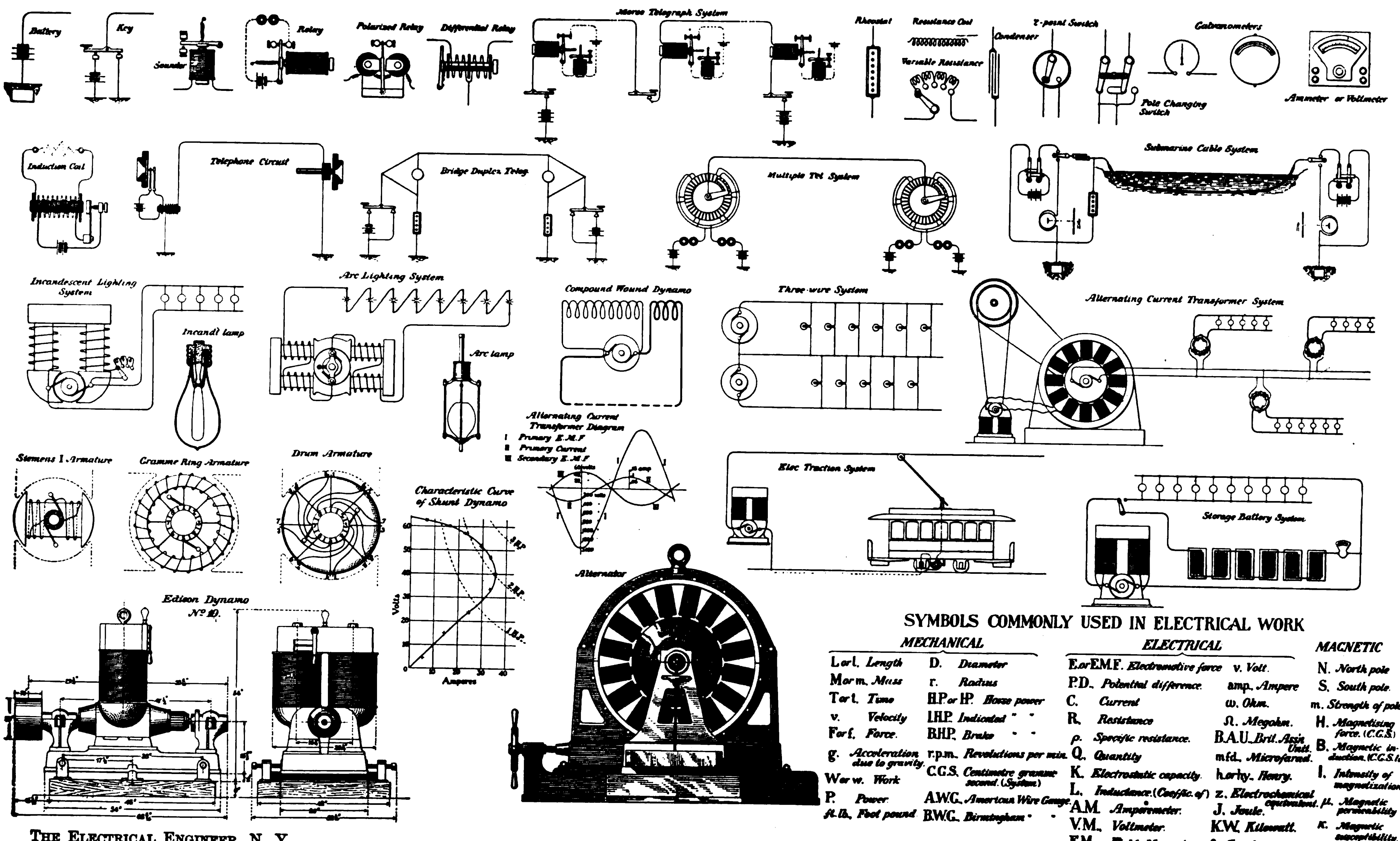
To obviate this leakage or brush discharge, I procured two glass tubes six feet in length, and drew the rubber-covered wires into them. By this means we increased the spark between the two spheres to three inches.

Now we have some idea of the difference between the air and other insulators when currents of high potentials are used, as compared with oil. If it means anything, it is, that high potential currents cannot be insulated by the air, but must be insulated with oil and placed underground. *Nous verrons!*

On the evening of May 5th, we had the Holtz machine in good condition at the Franklin Institute; it sparked seven inches between the spheres, and was witnessed by 48 members of the Electrical section. We had three jars of the Electrical Pousse-Café pattern, and sparked through the glass tubes of two of them without puncturing the insulation from wire to wire, where they were twisted together in the oil. The third one stood the strain while the spark was going a distance of five and a half inches, as measured by the president of the section, Prof. E. J. Houston.

CHART OF STANDARD ELECTRICAL DIAGRAMS & SYMBOLS

Compiled by Francis B Crocker for the Electrical Engineering Dep't Columbia College



SYMBOLS COMMONLY USED IN ELECTRICAL WORK

MECHANICAL

L or l.	*Length*	D.	*Diameter*
M or m.	*Mass*	r.	*Radius*
T or t.	*Time*	H.P. or HP.	*Horse power*
v.	*Velocity*	I.H.P.	*Indicated* " "
F or f.	*Force.*	B.H.P.	*Brake* " "
g.	*Acceleration due to gravity.*	r.p.m.	*Revolutions per min.*
W or w.	*Work*	C.G.S.	*Centimetre gramme second. (System.)*
P.	*Power.*	A.W.G.	*American Wire Gauge.*
ft. lb.	*Foot pound.*	B.W.G.	*Birmingham* " "

ELECTRICAL

E or E.M.F.	*Electromotive force*	v.	*Volt.*
P.D.	*Potential difference.*	amp.	*Ampere*
C.	*Current*	ω.	*Ohm.*
R.	*Resistance*	Ω.	*Megohm.*
ρ.	*Specific resistance.*	B.A.U.	*Brit. Assn Unit.*
Q.	*Quantity*	mfd.	*Microfarad.*
K.	*Electrostatic capacity.*	h or hy.	*Henry.*
L.	*Inductance. (Coeffic. of)*	z.	*Electrochemical equivalent.*
A.M.	*Amperemeter.*	J.	*Joule.*
V.M.	*Voltmeter.*	KW.	*Kilowatt.*
F.M.	*Field Magnet.*	∿	*Complete period (Alt. cur.)*
+	*Positive pole or terminal.*	⊸	*Dynamo.*
−	*Negative* " "	─┤├─	*Battery.*

MAGNETIC

N.	*North pole*
S.	*South pole.*
m.	*Strength of pole*
H.	*Magnetising force. (C.G.S.)*
B.	*Magnetic induction. (C.G.S. lines)*
I.	*Intensity of magnetization*
μ.	*Magnetic permeability*
κ.	*Magnetic susceptibility.*
H.	*Horizontal intensity of Earth's magnetism.*

THE ELECTRICAL ENGINEER, N. Y.

THE DIRECT ELECTRIC CO.'S STORAGE BATTERY TRACTION SYSTEM.

WHILE, as yet, the number of street cars operated by storage batteries is but small in comparison with the large number run by the overhead trolley system, indications are not wanting to show that steady progress is being made in the former method, and it is but a question of time, and probably a short time at that, when storage traction will command the serious attention of many who now look upon it as unworthy of serious consideration. It will be conceded at once that if a battery can be provided, capable of withstanding, first, the heavy usage of street railway work, without deterioriation for a long period of time, and, secondly, of a lightness such that its own weight forms but a small fraction of the total weight of the car when loaded, storage traction will at once be placed on a practical commercial basis.

With these conditions placed before them, Messrs. Montgomery Waddell, Justus B. Entz, T. H. Foote, and W. A. Phillips have worked out a system of storage battery traction which deserves attention on account of several novel features which have been practically embodied in a car now in operation on the Lehigh Avenue Railroad in Philadelphia.

The equipment and performance of this car, which is illustrated in perspective in the accompanying engraving, Fig. 1, may best be described by reference, first, to the type of battery employed.

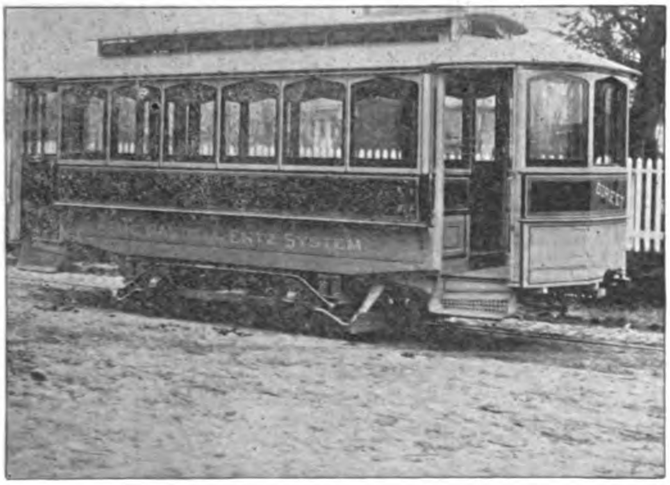


FIG. 1.—STORAGE BATTERY CAR OF THE DIRECT ELECTRIC CO.

The car, which has a vestibule at either end, for the motorman, is equipped with 100 cells, each weighing 30 pounds, and therefore weighing 3,000 pounds in all. Each cell occupies a space of 5 × 7 × 12 inches, and has a capacity of 800 ampere hours. The E. M. F. of the cell on open circuit is .9 volt, and on heavy work 0.8 volt.

The cell employed is of the alkaline zincate type and consists of eight negative and eight positive plates, placed in an iron containing cell. The copper positives are built up of convolutions consisting of a central core of copper wire surrounded by, and intimately connected with, the active material, consisting of a highly porous copper mass. The inventors claim to have overcome all troubles that have arisen in this type of cell due to loss by leakage and increase of internal resistance, and that the battery will remain charged for 3 months with a loss of only 3 per cent. of its charge. A number of cells that have been in use for over a year are apparently as good as new, though they have been short circuited repeatedly, and current taken from them at the rate of 1,000 amperes until entirely discharged.

The efficiency of the cell on heavy rates of discharge, such as it is subjected to in street car work, is 80 per cent., this being the difference in voltage on charge and discharge. The ampere hour efficiency is claimed to be practically not less than 100 per cent. This is due to the fact that no gas is given off either on charge or discharge, no matter what the rate. The cell has copper insulated cables with regular brass terminals, as there are no fumes; hence no corrosion of metal parts takes place. As a consequence also, there is no trouble due to contacts or terminals burning off.

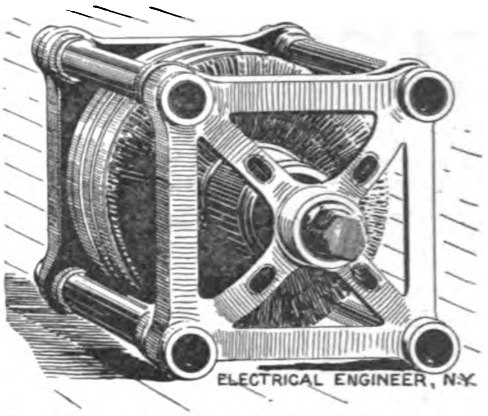

ELECTRICAL ENGINEER, N.Y.

FIG. 2.—THE DIRECT ELECTRIC COMPANY'S SINGLE REDUCTION STREET CAR MOTOR.

We now come to the motor with which the car is equipped, and to the peculiar and excellent qualities of which not a little of the success of the car is due. The motor which transmits its power to the car axle, with only a single reduction of speed, is of the 4-pole type and is shown in Fig. 2, while Fig. 3 shows the construction of the field magnets. These, as will be seen, are energized by a single magnetizing coil, and have pole-pieces bent back upon the coil. The cast iron end frames are rigidly united by four thick brass tubes, and Figs. 4 and 5 show the method of connection of the motor to the car axle.

The armature is a Gramme ring, and the magnets being on the inside, and requiring but a single coil, require the employment of but a small amount of copper and allow of a high efficiency being attained. Thus the wire on the field and armature weighs only 130 lbs. for a motor developing 20 h. p. The motor runs very cool and without sparking, even when the motor is reversed and the car stopped in its own length. The machine can also be changed from a motor to a dynamo by a turn of the switch, without showing perceptible sparking at the brushes. The motor weighs 1,200 lbs.

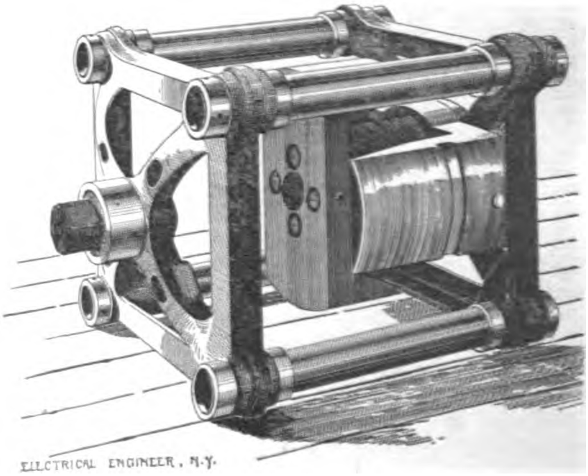

ELECTRICAL ENGINEER, N.Y.

FIG. 3.—FIELD MAGNETS OF STREET CAR MOTOR.

Recognizing the necessity of having a high efficiency over the large range of loads to which a street car motor is subjected, the motor has been designed with special reference to this point.

The armature resistance is .035 ohm, and the following are the losses by actual test:

Loss in Hysteresis	200	watts.
Loss in Foucault currents	120	"
Bearings and brush friction, and short circuited coil	180	"
Loss in field coil	200	"
Total constant loss	700	"

The small losses account for the high efficiency at small loads, as they are practically as high at no load, when the machine is running free, as at full load. The losses in bearings and short circuited armature coils increase slightly with load, but as they were measured when the motor was delivering 12 h. p. they are assumed to be constant for all loads. The loss due to the resistance of armature increases as the square of the load and so, of course, becomes a higher percentage with an increase of load .The point at which the armature loss due to C^2R equals the constant losses is the point of highest efficiency of the motor; this is at 14 h. p. where the efficiency is 88.5 per cent. commercial.

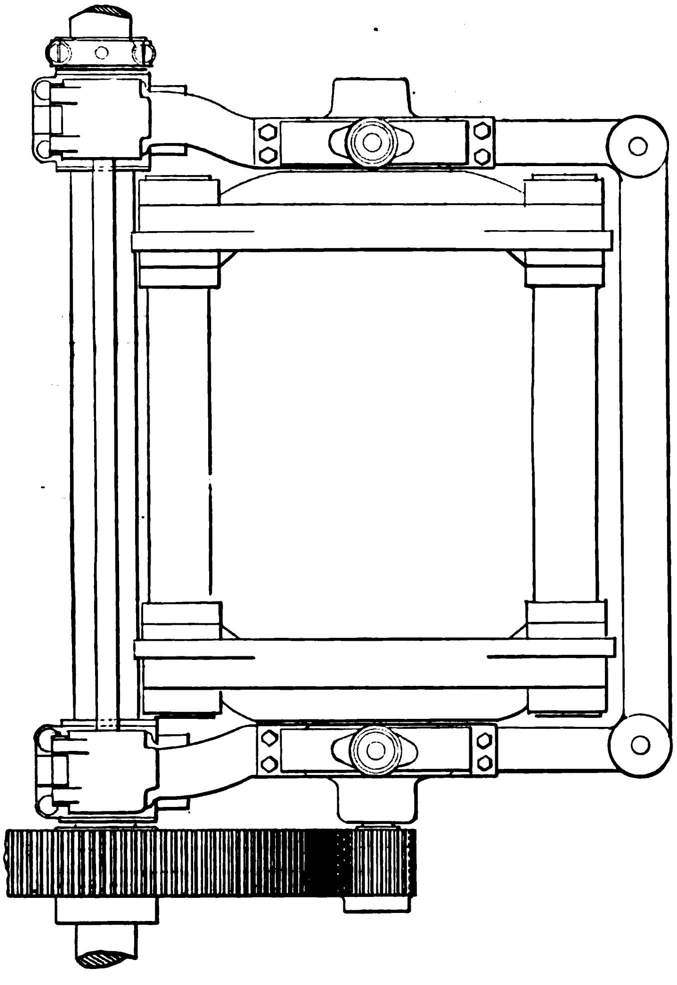


FIG. 4.—MOTOR FRAME AND GEAR.—PLAN.

The following table shows the commercial efficiency from 4 h. p. to 25 h. p.

4	h. p.	to	80	per cent. eff.
6	"	"	84	"
8	"	"	86.7	"
10	"	"	87.9	"
12	"	"	88	"
15	"	"	88	"
20	"	"	87.8	"
25	"	"	86.5	"

The average efficiency of the motor for the range of loads at which it runs is 86 per cent.; hence, with the batteries at 80 per cent. efficiency, this gives an efficiency from dynamo terminals to car axle of 86x.80 = 68.8 per cent., which is very high for traction work.

One of the most striking features of the car is the method for controlling its speed. This is done by means of a controller at each end of the platform which gives the car five speeds ahead and one back. The first 3 steps in the controller arrange the cells in different groups of series and multiple. The last two steps weaken the motor field. The reverse step reverses the car at its lowest speed.

By a combination of battery and field circuits, a constant field is kept on the motor, regardless of the amount or direction of the armature current. This enables the motor to be used as a dynamo and store back energy in the battery when stopping and going down grades, and prevents the car running away. So well does this arrangement fulfil its object that on a trip made by the writer the car was stopped in its own length when going at a speed of 12 miles per hour, and without jar. The car also ran down a 5.5 per cent. grade without using brakes, and without accellerating its speed in the least. Indeed, during the whole run up and down grades, and in starting and stopping, the brakes were not used once. This method of controlling the cars must add greatly to the efficiency of the system, as considerable power is stored in going down hill and when stopping the car. It also adds much to the safety of the system as the car can be stopped very much more quickly than with brakes, and the motor-man has only his controller to attend to, in order to have the car under complete control. Ordinarily, as is well-known, the current has first to be shut off from the motor and then the brakes applied.

The curve, Fig. 6, shows readings taken on a run with about 15 persons on board, and shows the considerable amount of power restored to the batteries in the form of current on down grades, and on slowing down or stopping the car. The amount of current taken from the cells was but 15.5 ampere hours for the out trip, as shown on the curve, and 30.3 amperes on the return trip, it being then mostly up grade work; the length of trip was just over 3 miles each way making a total of 45.8 ampere hours for the six mile run. The energy required to recharge the battery

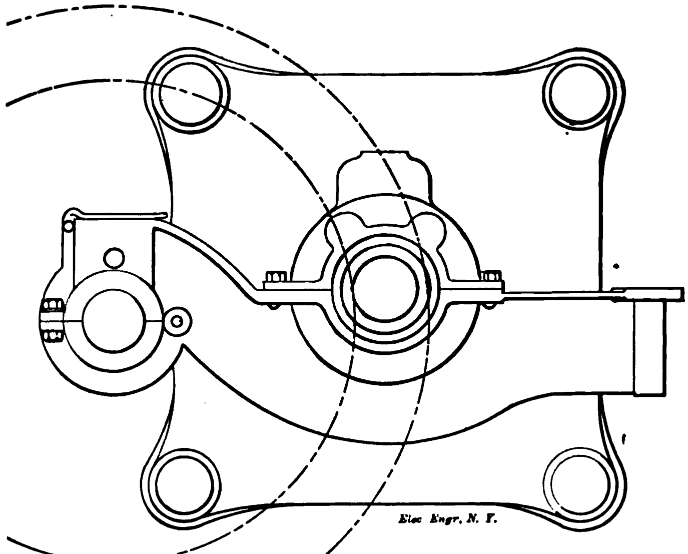


FIG. 5.—MOTOR FRAME AND GEAR.—SIDE VIEW.

for this run at the dynamo terminals would be 96 volts and 45.8 ampere hours = 4,400 watt hours = 5.9 e. h. p. hours, or 1 e. h. p. hour per car mile at the dynamo over a road full of severe curves and grades.

The car on a recent trip made the trip of 3 miles in 16.5 minutes with full load, and was then not going at full speed. The speed on a level is 13 miles per hour.

We may add that the car we have just described has been equipped by the Direct Electric Company, of this city, with the object of demonstrating the thorough practicability of storage battery traction, and they even hint at its application to heavy trains running at very high speeds. The car is being operated under the management of Messrs. Wright & Starr, electrical engineers, of Philadelphia, the company's agents in that district.

HYDROCHLORIC ACID IN BICHROMATE BATTERIES.

BY

Chas. Steinmetz.

I HAVE read with some interest, in the last issue of THE ELECTRICAL ENGINEER, Mr. Reed's remarks on the reactions which take place when hydrochloric acid is added to a bichromate cell; but I cannot quite agree with him, and for these reasons.

The chemical reaction which he alludes to,

$$Cr_2\,O_7\,K_2 + 14\,H_2\,Cl = Cr_2\,Cl_6 + 2\,K\,Cl + 3\,Cl_2 + 7\,O\,H_2$$

takes place only when bichromate is heated with concentrated hydrochloric acid, but *not* in a cold, dilute solution. Hence no free chlorine is present in the hydrochloric acid bichromate cell.

I am sorry that I have at present neither time nor facilities to determine by chemical analysis the exact composition of such a solution; but that no perceptible amount of free chlorine can be present is proven best by the entire absence of the penetrating, suffocating, and certainly characteristic smell of free chlorine. Besides this, the solution has no bleaching power, as a solution of free chlorine has, and acts upon organic matter—for instance, upon the cork of the bottle in which it is kept—in the same manner as strong acid, but not at all in the manner free chlorine destroys organic matter. If the chemical reaction should follow the above mentioned law, the amount of chlor developed would be so large that evolution of gaseous chlorine must be expected.

I did not investigate this phenomenon any farther, but I considered the advantage gained by the partial substitution of hydrochloric acid as a purely physical phenomenon due to the chlorides being generally more soluble than the sulphates, which difference of behavior is particularly great in the case of the two salts $Cr_2\,Cl_6$ and $S_2\,O_8\,Cr\,K$. In other words, $Cr_2\,Cl_6$ has very little tendency to crystallize, while $S_2\,O_8\,Cr\,K$ crystallizes very easily. Besides, the weaker chemical affinity of hydrochloric acid, which attacks the zinc less, furnishes another partial explanation of the resulting improvement.

Free chlorine is certainly a more powerful depolarizer than chromic acid, and, even if the reaction mentioned above should occur, we would not lose in depolarizing capacity, but would gain in intensity of depolarization. Free chlorine has, therefore, more than once been proposed as a depolarizer, but never found very extensive application, because of its many disagreeable properties, which make it worse even than fuming nitric acid. But in the hydrochloric acid bichromate battery it is not present in any perceptible amount.

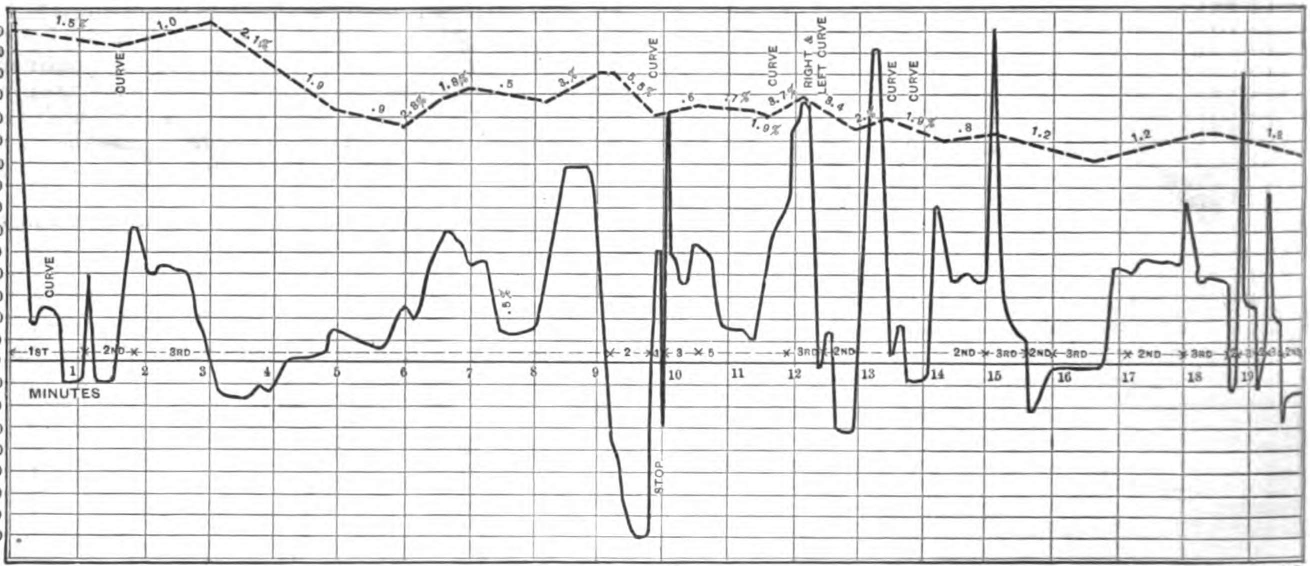


FIG. 6.—READINGS TAKEN ON A RUN WITH THE DIRECT CO'S CAR.

THE JAMES ACCUMULATOR.

IN this accumulator the positive plates consist of lead alloyed with 1 per cent. of cadmium, while the negative consist of 2 per cent. of antimony. The plates are pierced with circular holes, in which the active material is placed. Those on the positive plates are filled with a mixture of 8.5 parts of minium, 1 part of litharge, .4 parts of carded asbestos, and .1 part of powdered carbon. The holes in the negative plates are filled with a mixture of 9.4 parts of litharge, .1 part of sulphur, with .4 part of asbestos, and .1 part of powdered carbon.

UTILIZATION OF THE WATER-POWER OF THE RHONE.

As is well-known, the water-power of the Rhone is being largely utilized for industrial purposes in the neighborhood of Geneva. Col. Turettini (chief engineer of the St. Gotthard Tunnel), who carried out the works, has just issued a report as to the state of the work. The canal on the left bank is provided with 20 turbines, working up to 4,400 h. p., of which only half is at present in use. During the past year 216 motors, totaling 1,565 h. p., have been driven from the works. The smallest, of $\frac{1}{8}$ h. p., have been used to run sewing machines, while the largest (625 h. p.) has driven the electric light installation for the town of Geneva. The total cost of the works was $1,136,000., and the year's receipts reached $413,000.

CENTRAL STATION MANAGEMENT AND FINANCE.—IV.

BY

Horatio A. Foster

Form No. 4A is a general complaint card and is used for recording any trouble of which notice is sent in by customers by telephone or messenger, the proper word being crossed off to leave the other. These complaint cards are placed on a convenient hook where the inspectors can find them the first thing on entering the station. The inspectors must attend to them at once. When remedied and signed, they are turned into the office and filed in their proper place for further reference. It is certain that they will be needed many times to settle disputed bills.

(Form 4A.) Copyrighted 1891.

______________________189

*Complaint received at*______________. *M.*

by Telephone or Messenger.

*from*______________________

*No.*______________________*Street.*

*That*______________________

____

____

____

____

____

*Remedied satisfactorily*______________________189

*at*__________. *M.* *Signed*______________________

FORM 4A.—GENERAL COMPLAINT CARD.

Incandescent and motor circuits are generally run from buss bars, as in the direct current systems, or are switched from machine to machine when the indicators show increase or decrease of load, as in the alternating system. Therefore it is quite unnecessary to post any card showing layout of circuits on the switchboard. In arc lighting, however, it is different, and for stations having a number of dynamos it is quite essential that some special schedule of circuits be posted to enable the switchboard tender to arrange the circuits and machines to the best advantage. Form No. 7A is advanced for this and covers about all the points necessary to know as to what dynamos to use for the circuits and when to start and stop the same. This sheet is compiled from the circuit register, form No. 23, which is made up by the superintendent or superintendent of construction from reports of work done during the day, showing both construction of line and installation of new lamps.

(Form 7A.) Copyrighted 1891.

______________________Company.

*Dated*______________________189

ARC SWITCH BOARD.

The following arrangement of Circuits and Dynamos will be used until further notice.

*Signed*______________________*Dynamo Engineer.*

No. Dynamo.	Number of Circuits with Number Lamps Each.	Total Lamps.
	TOTAL	

START CIRCUITS AS FOLLOWS.

*All City Circuits*______________________ *at*__________*M.*

*Commercial Arc Circuits, Numbers*______________________

______________________*at*__________*M.*

*Motor Circuits, Numbers*______________________*at*__________*M.*

STOP CIRCUITS AS FOLLOWS:

*All City Circuits*______________________ *at*__________*M*

*Commercial Arc Circuits, Numbers*______________________

______________________*at*__________*M*

*Motor Circuits, Numbers*______________________*at*__________*M.*

FORM 7A.—ARRANGEMENT OF CIRCUITS AND DYNAMOS.

By the use of both of the above forms, viz., 7A and 23, form 7, the Daily Lamp Record, is filled out by the dynamo engineer. The object of this last report is to give the exact number of equivalent arc lamps burned during the 24 hours by arc lamps, and such other installation as are usually allied with them, such as series incandescents and arc or constant current motors.

This blank will be found of great convenience in figuring costs and together with form No. 8, the Ampere Report, gives the proportions and amount of output on which are based the calculations of all costs. Of course the report of ampere hours has to be reduced to its equiva-

(Form 23.) Copyrighted 1891.

CIRCUIT REGISTER.

*Station*__________*to*__________*to*__________*to*__________*to* *Circuit No.*__________

__________*to*__________*to*__________*to*__________*to*__________*to* *Make of Wire*__________

__________*to*__________*to*__________*to*__________*to*__________*to* *Gauge of Wire*__________

*Total Length*__________*ft.*

Number of Lamps Equivalent ______ A. P.	7 Nights with Sunday. Location.	All Day.	All Night.	P. M.	P. M.	A. M.	Motors.	Number Lamps.	6 Nights Only. Location.	All Day	All Night	P. M.	P. M.	A. M.	Motors.	Number Lamps.	Saturday Only. Location.	All Day	All Night	P. M.	P. M.	A. M.	Motors.	Rate.

FORM 23.—CIRCUIT REGISTER.

lent of arc lamps, of the c. p. used in the special station. This is easily done by a comparison of watts consumed by both arc and incandescents, which will give the proper basis for reduction. In figuring many hundreds of ampere reports for alternating circuits, the writer has found the following simple rule of great use in expediting calculation :—Where alternating currents of 1,000 volts are used and the lamps are 50 volts or the factor of reduction is 20, the readings being taken every half hour, by adding a cipher to the footing of the column of readings you have the lamp or ampere hours without any calculation whatever. For example, suppose the half hour readings are 12 and the total amount is 534, by adding a cipher it becomes 5,340 lamp hours at once. The following is the explanation :—534÷12 the number of readings gives us 44.5 as the average reading, and multiplied by 6 the number of hours makes 267 total ampere hours in the primary circuit; 20 lamps go to the ampere; therefore we multiply by that figure, which gives 5,340 (or the same result as above). If officials wish to go still further into detail, these ampere readings can be plotted on a cross-section card, thus giving a very handy curve or load diagram which is exceedingly useful in showing to the eye at once any faults with the circuits or stoppages, and how the business is running in general.

(Form 7.) Copyrighted 1891.

DAILY ARC LAMP RECORD

For 189

Style		Candle Power.	Number of Lamps.	Time Started.	Time Cut-out.	Hours Run.	Number Lamps Cut-out for Trouble.	Hours Cut-out for Trouble.	Total Lamp hours at c. p. Equivalent.
City		2000							
		1200							
Commercial Arc		2000							
		1200							
		-							
Series.		32							
		65							
Motors.		H. P.							
Totals.									
				Average hours burning per lamp.					

FORM 7.—DAILY ARC LAMP RECORD.

(Form 8.) Copyrighted 1891

189

Ampère Record 24 hours, ending 6 o'clock A. M., to-day.

Maximum ______ *amps.* *Minimum* ______ *amps.* *Average* ______ *amps,*
Equivalent 16 c. p. ______ *lamps.* *Equivalent 16 c. p* ______ *lamps* *Equivalent 16 c. p* ______ *lamps*

TIME.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	Feeder No.	TOTALS.
6.30 A. M.											
7											
7.30											
8											
8.30											

FORM 8.—AMPERE RECORD.

THE WASHBURN SECONDARY BATTERY.

AMONG the greatest difficulties in the way of the general adoption of storage batteries, and especially in railway work, has been the dropping out of the active material and the buckling of the plates. To overcome these disadvantages, Mr. George A. Washburn, of the Ford & Washburn Electric Co., of Cleveland, O., has devised a novel form of secondary battery shown in the accompanying illustrations. The battery embodies in its construction a porous pot which is employed to separate the positive and negative elements of the cell, as well as for holding the active material. As will be seen, Fig. 1 is a plan view, and Fig. 2 is a perspective view of the cell with one side and end removed showing the internal construction.

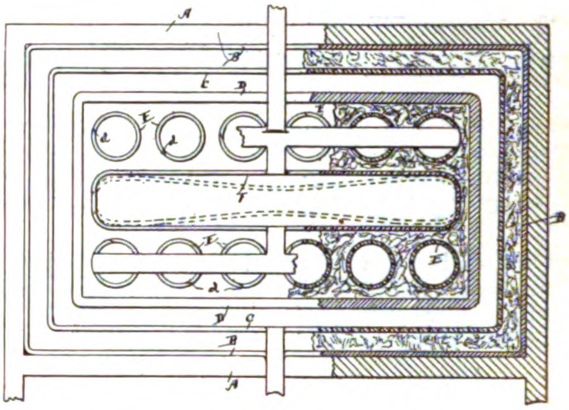


FIG. 1.—THE WASHBURN STORAGE BATTERY.

The cell consists in an outside containing vessel A, a cup B of lead forming a lining for the receptacle, and an inner perforated conducting-plate C, set at a distance from the cup B, so that active material may be placed between the cup and plate.

The porous cup D contains a series of conducting tubes E open at top and bottom, and also an inside perforated tube F, open at both ends and oblong in cross section, so as to have flat sides opposite the tubes E.

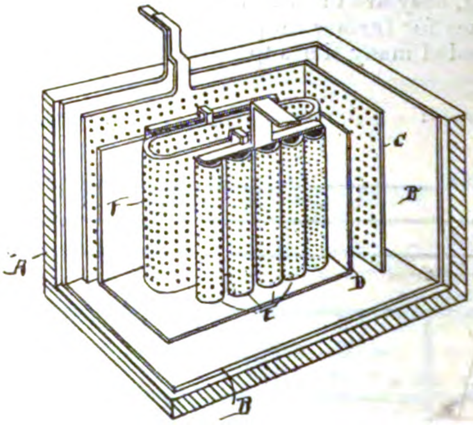


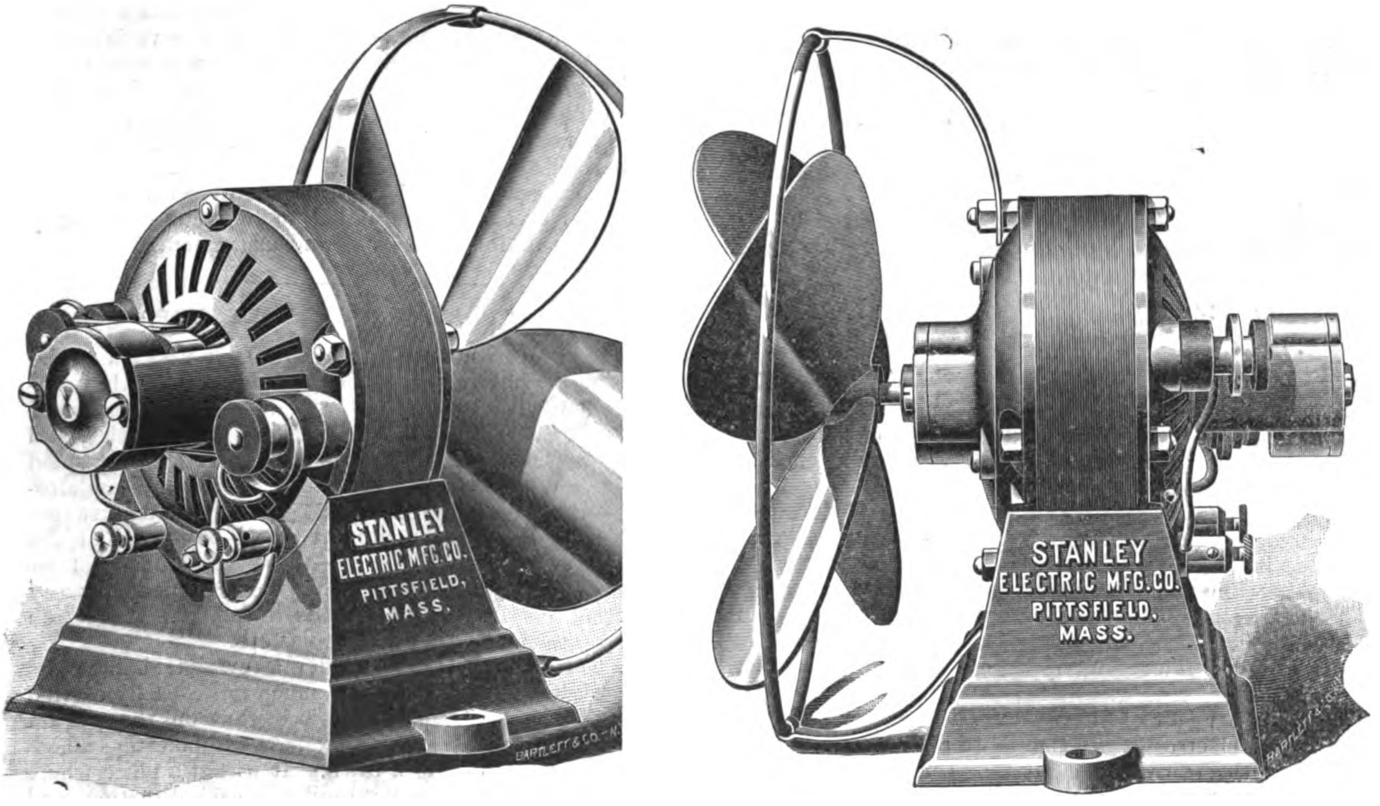
FIG. 2.—THE WASHBURN STORAGE BATTERY.

The positive electrode is arranged within the porous cup and, inasmuch as there is a tendency in the positive electrode to expand more or less, the conducting plates are so constructed that they will accommodate themselves to whatever expansion may occur, and thus save the cup. This is accomplished by making either the inside tube F alone in such a form that it will accommodate the lateral pressure exerted by the material in expansion, or by making the tubes E take up the expansion, or by constructing both with a view to the same result.

The active material is placed between the tubes E and the cup D and the central tube F, while the tubes themselves are filled with liquid. These tubes are liberally perforated, as shown in Fig. 2, so that there is the utmost exposure of the active material to the liquid, and that freedom of circulation through the cell which is necessary to the perfect working and highest efficiency of the battery.

THE STANLEY ALTERNATING FAN MOTOR.

As our readers are aware, Mr. Wm. Stanley, Jr., whose name is so intimately connected with alternating current work in this country, has recently begun the design of a number of specialties for the Stanley Electric Manufacturing Co., of Pittsfield, Mass., and as the first of these we recently described an improved transformer [1]. We are now able to present to our readers his alternating fan outfit which we illustrate in the accompanying engravings.



FIGS. 1 AND 2.—STANLEY ALTERNATING CURRENT FAN MOTOR.

The base of the motor occupies a space $3\frac{1}{2}$ x $5\frac{3}{4}$ inches, and the fan is $6\frac{1}{2}$ inches in diameter. The motor requires $1\frac{1}{2}$ ampere, but a trifle more current than a 16 c. p. lamp. The commutator is large, and the brush holder is permanent in adjustment, and the efficiency of the machine is said to be very high for a motor of this size. By providing self oiling bearings the care of the motor is reduced to a minimum, so that it needs no attention for weeks at a time. The motor has been designed specially for desk use, and to that end the fan gives a current which, while affording a cooling breeze, is not so strong as to blow about papers or subject the occupant of the room to the risk of catching cold.

MR. FRED H. ENGELL who has been in the employ of E. M. Carhart & Company, Providence, R. I., until recently, has severed his connection with that house.

EXPERIMENTS ON THE RATIO OF ELECTROSTATIC TO ELECTROMAGNETIC INDUCTIVE DISTURBANCE BETWEEN NEIGHBORING TELEPHONE CIRCUITS.—II.

A. E. Kennelly.

We may now check the previous results by calculation. The check can only be a rough one because we shall have to assume that the periodic variation of E. M. F. is a simple harmonic function of time, and that the inductance of the dynamo armature is negligible.

Let e, be the E. M. F. generated by the dynamo at any instant.

K, the mutual electrostatic capacity of the two circuits.

M, the mutual electromagnetic capacity of the two circuits.

p, the pulsation of the periodic variation of E. M. F. $(2\,\pi\, n)\ n = 1257$.

γ_c, the current in the secondary circuit at any instant in Fig. 2.

γ_m, the current in the secondary circuit at any instant in Fig. 3.

ω_1, the impedance of the primary circuit.

ω_2, the impedance of the secondary circuit.

r_2, the resistance of the secondary circuit.

All expressed in A. E. M. U.

Then in Fig. 2, if no resistance existed in the secondary path to ground, we should have

$$\gamma_c = -K\frac{d\,e}{d\,t} = -p\,K\,E\cos pt \qquad (1)$$

where E is the maximum $\pm$ periodic variation of e; but with resistance r_2 inserted as shown, the current becomes very nearly

$$\gamma_c = -\frac{E}{r_2}\cos pt \qquad (2)$$

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[1] THE ELECTRICAL ENGINEER. April 8th, 1891.

In the case represented by Fig. 3, we have

$$\gamma_m = -\frac{d\,e}{d\,t}\,\frac{M}{\omega_1\,\omega_2} = -\frac{M\,p\,E\cos pt}{\omega_1\,\omega_2} \qquad - \quad - \qquad (3)$$

and $$\frac{\gamma_e}{\gamma_m} = \frac{\omega_1\,\omega_2}{M\,p\,r_2} \qquad - \quad - \quad - \quad - \quad - \qquad (4)$$

Also since γ_e was adjusted to estimated equality with γ_m, we should have

$$\omega_1\,\omega_2 = M\,p\,r_2 \qquad - \quad - \quad - \quad - \quad - \quad - \qquad (5)$$

where $\omega_1\,\omega_2$ was 1.9×10^{25}
r_2 " 7×10^{15}
p " 7.9×10^3

and M calculated for two circuits forming a rectangle of 12,000 × 3,000 cms. is nearly 2.0×10^5

$$\therefore\ M\,p\,r_2 = 1.1 \times 10^{25}$$

The two members of equation (5) were thus experimentally of the same order although the agreement is by no means close.

It may be fairly concluded that when two insulated wires run parallel and close together, a periodic E. M. F. acting on the circuit of one is liable to induce disturbances in the other, of which the greater part will be due to electrostatic effect, unless the product $\omega_1\,\omega_2$ is less than the ratio of their electromagnetic to their electrostatic mutual capacity.

For parallel copper wires suspended at the same height above ground, and both using ground return circuit, this ratio is, in A. E. M. measure,

$$\frac{M}{K} = 3.6\left\{\left(\log_e \frac{2h}{r}\right)^2 - \left(\log_e \sqrt{1 \times \frac{4h^2}{d^2}}\right)^2\right\} \times 10^{21};(6)$$

where r, the radius of each of the wires (in cms.).
" d, is the distance between their axes (in cms.).
" h, is their common elevation above ground (cms.).

This ratio increases with the intervening distance d, so that the closer the wires, the greater the electrostatic effect. The maximum value the ratio can attain under practical conditions is about 5×10^{23}, so that the product of the impedance in ohms of the primary and secondary circuits should not exceed 500,000 if magnetic induction is to be in the ascendant. Thus, if the primary circuit has 1,000 ohms impedance, the secondary should not have more than 500 ohms.

The particular pair of circuits experimented with in this case, favored electrostatic action more than would be usually the practice of overhead circuits, for the ratio M/K was only 2.67×10^{21}, making the limiting ohmic product of the two circuits 2,670 ohms, while M/K is commonly about 2×10^{23} for a pair of pole lines, increasing the range of the ohmic product to 200,000. It is also to be observed that when the impedance in the primary circuit is small, and especially when it is situated at the transmitting end of the line, the variation of electrostatic potential, and consequently induction, will be greatly reduced, and the above rules for estimating the proportion of static and magnetic disturbance only approximate the truth when the impedance of the primary circuit is large, and particularly when situated at the receiving end of the line.

As the lengths of the circuits increase, the greater will be the electrostatic share of disturbance, all other conditions remaining constant.

It is remarkable how small a mutual electrostatic capacity suffices to establish audible telephonic inductive disturbance of static nature, between two conductors. In fact, when the resistance to ground of the secondary circuit happens to be very high, the disturbance due to a small mutual static capacity would be hardly, and often inappreciably, increased, if the two circuits were connected metallically. For with the connections of Fig. 2,

$$\gamma_e = \frac{K\,\dfrac{d\,e}{d\,t}}{\sqrt{1 + p^2\,k^2\,r_2^{\,2}}} \qquad - \quad - \quad - \qquad (7)$$

and when r_2 is more than ten times $1/p\,k$ this becomes very nearly

$$\gamma_e = \frac{p\,k\,E\cos pt}{p\,k\,r_2} = \frac{E\sin\left(pt + \dfrac{\pi}{2}\right)}{r_2}, \qquad - \quad - \qquad (8)$$

and this is the strength of current that would be set up in the secondary circuit if the E. M. F. acted upon it directly.

As an instance of this, it was found that if the dynamo above mentioned were connected directly with the telephone through a condenser of 0.001 microfarad, and a resistance of 2.5 megohms in simple series, the clearly audible dynamo note was not appreciably strengthened by short-circuiting the condenser. In fact, substituting these values in the last equation with 7.9×10^3 for p, the ratio of the current without condenser to that with condenser in circuit is 1.0015 on the assumption of a pure sine variation of E. M. F. The same result should have followed with a condenser of only 0.00016 microfarad, allowing a ratio of 1.05 between the two currents as the limit of audible appreciation. This experiment can be verified with a few feet of gutta-percha covered wire lying on the ground as a condenser and a graphite resistance in circuit with the telephone, after precautions are taken to ensure the necessary degree of insulation in the wire and instrument.

A SIMPLE POCKET POLESTEP.[1]

The need of trimming arc lamps daily first led to the use of a light, but sufficiently long, ladder which the trimmer carried with him on his rounds. Later the upper rounds of this ladder were transferred to the poles, and the general adoption of the so-called polesteps shortened the portable ladder and threatened to stop its use altogether. But to guard against any undesirable manœuvers on the part of the ever present small boy—and of the more dangerous big boy as well—these steps must not go down to the foot of the pole. So the trimmer, in many places, still carries on his rounds a small ladder which reaches up to the lowest of the polesteps.

As a substitute for this ladder a few detachable polesteps may be used, as they are much more easily carried about. Such a device has lately been put on the market and reminds the writer of some home-made polesteps which he saw in use in an eastern town. It was at a place where the circuits spread out several miles in each direction, and many of the lamps were on the hills some three hundred feet above the level of the rest. Such a topography made the carrying of the ladder quite a burden, and the ingenious trimmer soon hit on an easier plan. He drilled three holes into the sides of every pole at about the points where additional polesteps would be placed, slanting the holes slightly downward. Three short wooden pieces, whittled out of a broomstick, formed the steps for which these holes served as sockets. Then with the wooden pegs hung from his tool-belt by little wire hooks, he started out on his rounds better equipped and yet less loaded down than before. These pocket polesteps proved quite a boon to the trimmer and might well be more widely used; while up in a station attic lies a partly decayed trimmer's ladder which may some day be shown to visitors as a relic of early methods.

Mr. J. B. Nelson has resigned his position as manager of the Glens Falls, N. Y., office of the Commercial Union Telegraph Co., and will be succeeded by Mr. Nathan E. Stafford, who has been employed in the office for some time.

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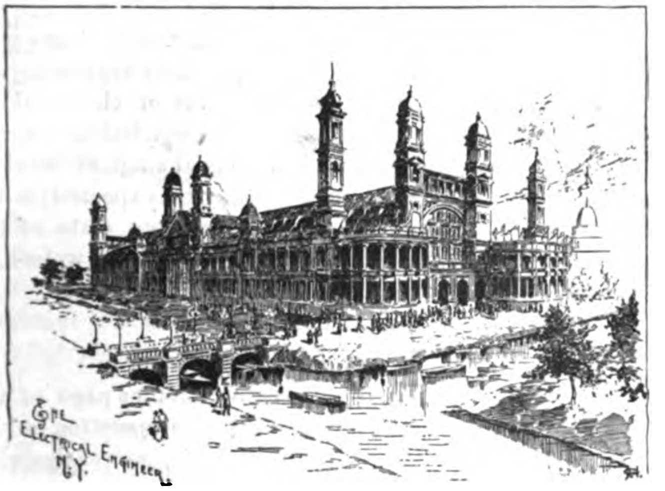
[1] See The Electrical Engineer, Feb. 18, 1891.

THE ELECTRICAL BUILDING AT THE WORLD'S FAIR.

The chief aim of the architects of the building for the World's Fair electrical exhibit, Messrs. Van Brunt & Howe, of Kanas City, Mo., has been to furnish a structure that will bring out to the best possible advantage the important feature of electric lighting. The towers, the great open portico in the avenue, the flag-staffs, the mural bays and projections, and the windows, were all studied and experimented upon and redevised, in order that no chance might be overlooked.

The dimensions of the building are generous, and yet complaint has been made that it is altogether too small for the purpose. This complaint is just, and it is possible that the building will be enlarged. Its dimensions, as now understood, are 766 feet in length, and 350 feet in width. The area covered is 211,190 sq. feet, or 4.85 acres.

The building is in the style of the Italian Renaissance. At each corner a spire rises to the height of 169 feet, and the rigidity of the rectangular construction is further relieved by other spires and domes, which give a lightness and airiness of design appropriate to its purpose. On the south front is a niche, covered by a half dome, 78 feet in diameter and 103 feet in height, in the centre of which will stand a colossal statue of Franklin.


Electrical Engineer N.Y.

THE PROPOSED ELECTRICAL BUILDING, WORLD'S FAIR, CHICAGO.

The walls exteriorly will be of "staff" a kind of stucco which can be wrought into the exact effect of marble. The porticos and loggia are to be variously enriched with colors. The details of the interior will be made ornate with enriched pediments, panels, friezes, and spandrels. On the frieze in each bay is to be the name of some discoverer or inventor. These names will preserve a chronological order, and will represent chapters in the history of electricity.

GRAPHIC METHOD FOR ANALYZING LOSSES IN ARMATURE CORES, ETC.[1]

BY R. H. HOUSMAN.

It has been found possible, by a simple graphical construction, to separate the different losses in armature cores without any recourse to mathematics at all. The method is as follows: Measure the current required to run the armature as a motor light with different volts on the armature, the magnets being separately excited so as to keep the field constant. On plotting the results as a curve, as in A B, Fig. 1, it will be found that the curve is a perfectly straight line, cutting the axis of current at some distance from the origin.

Now, taking any point B on the curve, and drawing B C parallel to A O, it is evident that the total loss is represented by the product O C × C B.

Next draw A D parallel to O C; this divides the area representing the total loss into two parts, one of which, O D, is proportional to O C, and the other, A D × D B, is proportional to the square of O C, since B D is proportional to A D which = O C. The first of these areas represents the waste of energy per second due to hysteresis and friction combined, while the second gives the loss due to Foucault currents. It must be noticed that it is the product of the co ordinates of any point on A B which represents the waste, and not the area of the figure A O C B. In this respect the diagram resembles the characteristic of a dynamo rather than the diagram of a steam engine.

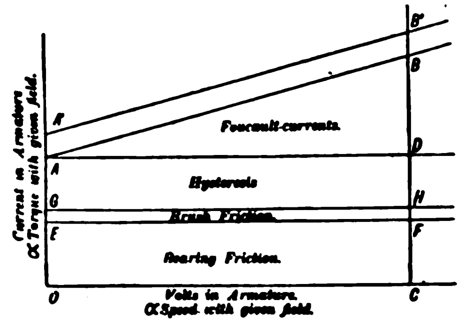

B'
B
A'
Foucault-currents.
D
A
Hysteresis
G
H
Brush Friction.
E
F
Bearing Friction.
Current in Armature ∝ Torque with given field.
O
Volts in Armature. ∝ Speed with given field.
C

FIG. 1.—GRAPHIC METHOD OF ANALYZING ARMATURE LOSSES.

Friction of bearings and brushes must be determined separately by coupling direct to a similar motor, and observing the increase of current required to drive with the fields unexcited. This will be constant at all speeds.

From this experiment draw O E equal to the current observed as required for friction alone, then E F being drawn parallel to O C, the rectangle O F represents loss by bearing friction. By a similar experiment the loss by brush friction may be determined, and G H drawn, so that E H represents the loss from this cause. The remaining rectangle G D will then show the loss due to hysteresis. It will be readily understood that only the losses represented by G H × H B (Foucault currents + hysteresis) appear as heat in the armature.

A second set of experiments may be made with a different strength of field, and plotted in a curve A' B', which is in general parallel to A B, showing that Foucault currents are constant for given volts. A' B' will be above or below A B, according as the change of field intensity has increased or diminished the sum of the losses due to hysteresis and friction, these two varying inversely, though not in simple inverse ratio.

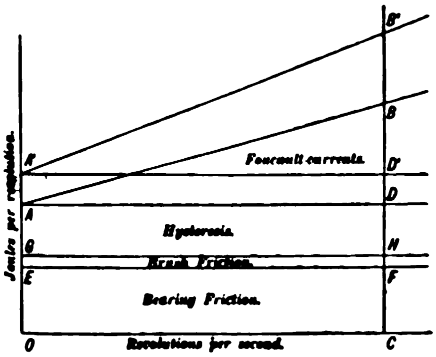


FIG. 2.—GRAPHIC METHOD OF ANALYZING ARMATURE LOSSES.

In Fig. 1, all the quantities have been measured electrically, hence it may be called the electrical curve, to distinguish it from another diagram which may be derived from it, in which the quantities are measured in mechanical units.

In Fig. 2, the same friction line holds good for all intensities, and the frictional and electrical losses are separated by the line G H. It will also be seen that the quantities G A and G A' represent the losses by hysteresis, in Joules per cycle, at the two intensities, for which A B and A' B' are drawn respectively. The loss per cubic centimetre from this cause is always found to be much greater than that generally given.

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[1] *Electrician.*

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VOL. XI. NEW YORK, MAY 13, 1891. No. 158.

A patent for an invention forbids no man to carry on the industry and business he has always carried on. It cannot raise the price, for people may manufacture in the old way; the patentee only has the sole right to use the new method he has invented.—James J. Storrow.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE programme published of the Annual meeting of the Institute in this city next week, and the arrangements now announced, go to show that the occasion will be one of great interest and importance. The papers cover a a variety of leading topics, and, with the discussions they elicit, are likely to be additions of permanent value to the literature of the profession. The growth of the Institute from the start in 1884 up to the present time has been steady, and, though never slow, has always been free from "boom" or undue forcing. Its work was long since recognized as on the highest plane, and its membership, now between 500 and 600, embraces the very strength and stamina of electrical engineering in America. Fortunately, too, the Institute will enjoy in its meeting here, the kindly cooperation of the New York Electric Club, the pioneer in its own special work, and a body which has done inestimable service in promoting friendship and social intercourse in a field whose commercial antagonisms have been of the bitterest nature. The working together of these two powerful bodies for a common end—namely, the raising of the standard of electrical thought, action, and influence, in this city and throughout the country—should be attended by notable results; and we venture to hope that the coming week will be one of great pleasure and profit for all who take part in the proceedings at the Institute and the Club.

A STANDARD CHART OF ELECTRICAL DIAGRAMS AND SYMBOLS.

WE have drawn attention on more than one occasion to the necessity which is becoming more and more felt of providing a uniform system of nomenclature in magnetic and electrical work, and the subject has been agitated in various quarters. Several years ago Prof. Jamieson, in a paper read before the Society of Telegraph Engineers and Electricians, pointed out the wide discrepancies which existed, and showed, by references to standard works, the diversity of signs and symbols applied to designate the same things. He suggested at that time a series of standard symbols and signs, but as yet no official action has been taken by any of the recognized electrical bodies in this matter. In the meantime the steady progress of the science and art requires more than ever the establishment of conventional abbreviations and characteristic diagrams, and recognizing this want, Prof. F. B. Crocker has prepared for his students at Columbia College a chart which we reproduce on another page. Prof. Crocker has been careful to select the most characteristic diagrams, and his abbreviations will be found to be those most approved among the electrical fraternity to-day. The diagrams especially will, we are sure, prove of considerable aid, not only to students generally, but to all those who are required to represent pictorially or graphically the various kinds of electrical apparatus and their functions. While electrical nomenclature has probably not yet reached its final stage of development, and changes and additions may be expected in the future, as an accurate record of the present state of the art in this respect, the chart is one which will be welcomed and utilized by many.

STORAGE BATTERY TRACTION.

THE description which we give on another page of the system of storage battery traction now in operation on the Lehigh Avenue Railway in Philadelphia, serves again to draw attention to the requirements of this class of work, and claims consideration on account of the methods employed. It is evident that, given a battery possessed of sufficient length of life, it is immaterial whether it accomplishes its work by delivering a small volume of current at a high E. M. F. or the reverse. In either case the motor can be adapted to the particular conditions of operation. We are led to this reflection by the general impression apparently existing, that a low voltage cell is not adapted for traction work. In the type of cell employed in the experiments described, the working E. M. F., does not exceed .8 volt; but it will be readily seen that the rate at which the batteries can be drawn from in amperes is higher, in the same proportion as the E. M. F. of the lead storage battery is over that of the type of cell used. It will also be noticed the weight of the cell employed to operate a car is very much reduced on account of the employment of copper instead of lead. But perhaps of equal interest, not only from the theoretical, but from the practical standpoint, is the performance of the motor. The curve of ampere readings shows in what manner the energy is restored to the cells when stopping and on down-grades, which, of course, is only made possible by controlling the motor entirely by the switch and without the use of the brake. If the life of the cell of the type employed on this trial shall prove reasonably long, we are free to say that storage battery traction has advanced another step towards being a dominant factor in street railway traction.

ELECTRICITY IN MINING.

THE promising field which the mining industry presents for the application of electricity both to lighting and power purposes has been too often pointed out to require any extended reference at this time, but the importance of a recent development in this field deserves more than passing notice. In many mining operations and in tunneling, the driving of the headings forms a most important part of the cost, and of this the item of labor forms by far the largest fraction. Any apparatus, therefore, which will lessen the time required to bring down a certain quantity of rock, will inure to the direct reduction of expense. We believe that the electric drill in destined to bring about in a marked degree this economy, and the powers of this new instrument as compared with the older types of air and steam drills are well brought out in the paper read by H. Ward Leonard before the Quebec Association of Mining Engineers. The description of the various types of drills adapted for different classes of work is evidence of the fact that there is practically no department of mining which cannot be successfully carried out with the aid of electricity, in most cases with a marked degree of economy and especially so where water powers are available. Mr. Leonard has added considerably to the value of his paper by the addition of a chart and formulae, which if intelligently applied will allow of the most direct calculation of much important data in connection with the installation of both lighting and power plants.

ELECTRICITY AND THE MODERN CITY.

WE took occasion lately to comment on the Census figures relative to electric traction and those which purport to show an undue growth in urban population. While we are fully aware of the existence of many things that render a city more and more attractive, doubt arises in our mind as to whether the last decade has not seen an exaggeration of the cityward tendency from the sore lack of rapid transit facilities. The love of pure air, green grass and waving boughs is as strong to-day as it ever was in the breasts of even the majority of dwellers in a city, but so long as it takes a couple of hours out of each day to go to and from a desirable suburb, so long the majority will be condemned to a narrow city dwelling place. This is "the problem of our great cities" in a nutshell, and the problem can be solved, it seems to us, by bringing the rapid transit facilities, with the aid of electricity, up to the needs of the various crowded communities. An electric express service to Yonkers and New Rochelle, Stamford, Tarrytown, and other towns out in the country, would do more to mitigate and abolish socialistic fume and rant than all the preaching and slumming. The workman who is cheaply carried 20 miles out into the rural parts of this State in 20 minutes to his own home, on May First, is not going to waste his time that day in weary processioning over dusty city stones and under a flaring red flag.

Electric Railway Innovations.

NOTE has been made in these columns now and again of innovations due to the introduction of electric cars, such as special freight service, funeral trains and the like. The flexibility of the method invites to the trial of novelties of this kind, and thus we are not surprised to hear that the handsome Short car in Cleveland has lately been utilized for afternoon teas, so that not only could one sip the social Bohea but make a pleasant, smooth trip through the green avenues. The same car has also, we hear, been used lately by one of the officers of the company in making a tour of inspection of the various suburbs, in search of a new home, stopping at any point and switching from road to road as fancy dictated. Many a weary house hunter would have been glad of such a special car this spring, and we don't see why "afternoon tea" cars and "house hunter" cars cannot be made a profitable feature of the business, just as special theatre cars are.

Lieut. Patten's Alternating Motor.

WE have already had occasion to describe several types of alternating motors designed by Lieut. F. Jarvis Patten, and this week give the two latest forms. In these types Lieut. Patten has ingeniously applied the method of directing the alternating current so that the machine is continuously energized by currents of the same polarity. The pulsating field current employed would naturally require a lamination of the field to avoid losses due to Foucault currents. The motors of Lieut. Patten are interesting examples of the wide range of types available in alternating motor work, being of the class which start as true alternating machines and, when running at their normal speed, are converted into motors of the continuous current type, fed by a rectified alternating currents.

Woman's Work In Electricity.

So little work has been done by women in the field of electricity, that we may be pardoned for calling attention to the fact that we review elsewhere this week two books on electricity, one by Mrs. J. E. H. Gordon, and the other by Emma Marie Caillard. This is a hopeful indication of the manner in which electricity has become part and parcel of daily life, and of the work it still has to do in the home in lessening the burdens of household duties. Women today are doing the bulk of domestic toil in a simply barbaric way, because mechanical power has not been at their command. The modern distribution of electric current is changing all this, and in a few years we shall see a number of electric labor-saving appliances in every house entered by a wire and connected with a central station.

The World's Fair Electrical Exhibit.

WE give in this issue a view of the building that has been designed for the electrical exhibit at the World's Fair, Chicago. Nothing is final as yet, however, and it seems as though considerable provision must still be made for the steam plant, the building shown being intended only for the electrical exhibits proper. There appears also a sad lack of appreciation in some quarter or other of the part that electric motors could be made to play in driving exhibit machinery all over the Fair.

THE ELECTRICAL TRANSMISSION AND CONVERSION OF ENERGY FOR MINING OPERATIONS.[1]

BY H. WARD LEONARD.

THE transmission and conversion of energy is above all others the question of importance in every kind of engineering work, and in mining engineering this is most conspicuously true.

The transmission and conversion of energy by water, steam, cables, compressed air, and so forth, we are all familiar with, and we know to our sorrow the limited distance, the low efficiency or the tremendous first cost which has hampered our engineering work at every turn. With the utilization of electricity for the transmission and conversion of energy we absolutely reverse these conditions and are enabled to operate at practically unlimited distances, with extremely high efficiency and very low first cost.

The great variety of the applications in the mining field, the distance from the mines to the principal cities where electrical developments have been most rapid, and the lack of knowledge as to the exact requirements have, until recently, made even the simplest applications of electricity to mining rather rare. Perhaps the greatest stumbling-block has been the percussion drill. Until recently, when a mine owner asked if we could transmit his power, light his mine and operate his pumps, hoists, tramways and mills, we could confidently reply, "Yes!" But when he asked if we could replace or operate his air drills, we were obliged to say, "Not yet." Since the drill is the most universal of all mining appliances operated by power other than hand power, it was not possible to make rapid progress until this deficiency was corrected.

The Edison General Electric Company has put upon the market in commercial form, during the past thirty days, three types of electric drills which will enable the mining engineer to accomplish all that he has been able to accomplish heretofore by other drills, and not only this, but to accomplish far more than was heretofore possible and under conditions heretofore prohibitory.

First in importance comes the Electric Percussion Drill, the invention of H. N. Marvin, of Syracuse, N. Y.

Following is a brief description of the principal features of the drill:

Fastened upon a suitable tripod or column is a piece of boiler tube seven inches in diameter and about two and a half feet long. In the forward half of this casing are placed two cylindrical coils of wire in the form of solenoids, each about eight and a half inches long, having an outside diameter of about six and three-quarter inches, so as to make a loose fit with the casing, and an inside diameter of about two and one-eighth inches. These two solenoids are placed so as to be against each other, end to end, in the casing. The bit plunger plays freely through the centre of these solenoids and is supported by two bearings placed just beyond the outside ends of the two solenoids respectively. The back portion of the casing contains a spiral spring of the form frequently used for car springs. The plunger is composed of a central portion made of wrought iron about 14 inches long and both the forward and back portion of the plunger, which are made of aluminum bronze, are rigidly fastened to this iron portion. The forward portion is about 13 inches long, and carries the bit socket. The back portion is spirally milled for a length of about nine inches so that the cross section of this portion is hexagonal. At the extreme back end is a steel buffer which strikes against the cushioning spring.

The spirally milled portion of the plunger is similar to that used in other percussion drills, and causes the drill to revolve upon its axis one-sixth of a complete turn with each stroke. The ends of the coils of wire are brought to contact pieces at the top of the adjacent ends of the two solenoids, where there is a socket for receiving the terminals of the cable and thus making electrical connection with the drill. There are three conductors leading from the generator to the drill, one of which is connected to one terminal of each of the solenoids, and the other two conductors are connected to the two remaining terminals of the solenoids respectively.

The generator is of the simplest kind, the coils on the armature having their terminals connected to two insulated collars on the shaft.

One collar is a continuous metallic ring, and upon this one rests a brush which is connected with the conductor, which is common to both solenoids. The other collar is metallic for half of the circle, and the remaining half is insulated from the armature wires. Upon this half ring rest two brushes diametrically opposite each other, and each brush is connected to one of the two remaining conductors leading to the solenoids in the drill.

If we now revolve the armature of our generator in a separately excited magnetic field an electric current will flow, let us say, from the armature to the half ring, then through one of the two brushes which happens at the instant to be in contact with the half ring along the corresponding conductor to one terminal of one solenoid, let us suppose the rear one. Then through the rear solenoid itself and back along the mutual wire to the continuous ring, and then to the armature again. This current in passing through the rear solenoid makes a powerful magnet of it, and this tends to pull the plunger back into a position such that the centre of its iron portion shall be in the centre of the rear solenoid.

When the armature moves forward a half revolution the polarity of its wires is reversed and the other brush with its conductor is now in contact with the half circle. Consequently, the current in the mutual wire will be in the reverse direction from that of the former wave; the rear solenoid and its conductor, formerly active, are now out of circuit, and the circuit is made through the other conductor and its corresponding solenoid, that is, the forward solenoid. The magnetic action of this solenoid now tends to make the plunger move forward so that the centre of the iron portion shall be in the centre of the forward solenoid.

Thus we get a reciprocating action of the plunger and every revolution of the armature of the generator will cause a complete stroke of the drill. By varying the speed of revolution of the generator we can make the drill strike any number of blows, per minute, we choose. In usual practice 600 blows per minute is found to give excellent results. The spiral spring, it will be observed, stores up the energy of the back stroke and returns it to the forward stroke, assisting the magnetic impulse and greatly increasing the strength of the blow.

Besides possessing the requirements of a first-class power drill, as stated by Andre many years ago, the Marvin drill has many other advantages not possessed by the steam or air drill; thus, it takes up very little space, and the length of the stroke is variable at will.

It will operate in the open air without striking anything, and hence can be made to strike an extremely light blow at its full rate, which is very important in starting holes, and so forth. It can be rapidly moved from one position to another at a great distance, since the energy is transmitted through flexible cables. No loss is suffered due to elbows, bends, valves, and so forth, in the conductors, and the efficiency of the drill itself is greater than that of any other type.

The importance of the above characteristics will be apparent to any one who is familiar with the operation of the steam and air drills. It is interesting to note that in driving the Hoosac Tunnel the average life of the power drills, before sending them to the shop, was 50 hours. Even to-day, after a development of 25 years, we find that it is common practice to have in the shop one-half the total number of drills employed.

To increase the rate of drilling we must either increase the strength of each blow or else we must increase the number of blows per minute. But the strains and shocks caused by the valve and the air or steam soon become troublesome as we increase the rate of striking. With the electric drill the speed of rotation of a perfectly balanced cylindrical armature of small diameter has no such limitations and there is apparently no limit to the rate of striking, except the magnetizing and demagnetizing of iron which is already done in daily commercial practice at the rate of 10,000 times per minute with the highest efficiency. With 800 blows per minute we have already drilled at the rate of four inches per minute a hole 1½ inches in diameter in the hardest Quincy granite, and that with an expenditure of energy not exceeding 3 h. p. I firmly believe that in a comparatively short time we will be furnishing percussion drills whose rate of striking will be several times as much as that we now employ, and that, with no more and no heavier drills than are now used, the rate of driving a heading will be increased many times.

A bulletin from the Census Department, under date of March, of this year, shows that in granite quarrying the cost of labor is 84 per cent. of the total cost of production, and in Massachusetts, where the out-put is much greater than in any other state, and where the longest experience and most approved methods are met with, the labor is 82½ per cent. of the total cost. It will be evident that any labor saving device in such a field will be extremely valuable.

Another drill of great value to the mining engineer is the diamond drill. The Edison General Electric Company have, during the past thirty days, put upon the market an electric diamond drill which they have been developing for the past two years. The drill is the invention of I. E. Storey, of Denver, Col. It presents a great many advantages over the diamond drills heretofore used, as will be evident from the following description of it.

The drill weighs complete 239 pounds. The average power consumed is about 1¾ h. p., and with this expenditure of power the drill will bore a hole of 1¼ inches diameter in hard rock at the rate of two inches per minute, taking out a core of ¾ of an inch. The drill rod is rotated at the rate of 400 revolutions per minute without any load and when drilling at full load the speed is practically the same.

The drill rod is geared by a single set of gears to an electric motor which revolves at 1,600 revolutions under conditions of full load. The motor has four poles and the keeper joining the poles is in the shape of a surrounding cylindrical shell, which thoroughly protects all the parts of the motor and other parts of the machine. Upon the drill rod is placed a rotary pump which supplies the drill with the necessary water.

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[1] Abstract of a paper read before the Association of Mining Engineers of the Province of Quebec, April 29, 1891.

RESUME OF FORMULAS FOR DEVICES IN MULTIPLE ARC.

Compiled By H. Ward Leonard.

				Size.	Weight.	Cost.
Conductors as determined by losses therein.	Incandescent Lamps.	Two Wire System.	General Cases.	$M = \frac{\text{T. c. p.} \times D \times 16.000}{e \times V \times \text{C. h. p.}}$	$T = \frac{D^2 \times \text{T. c. p.}}{V \times e \times \text{C. h. p.} \times 1{,}000.}$	$\$ = \frac{D^2 \times \text{T. c. p.} \times L}{V \times e \times \text{C. h. p.} \times 1{,}000.}$
				$M = \frac{\text{T. c p.} \times D \times W \times 21.5}{e \times V}$	$T = \frac{D^2 \times W \times \text{T. c. p.}}{V \times e \times 746{,}000}$	$\$ = \frac{D^2 \times W \times \text{T. c. p.} \times L}{V \times e \times 746{,}000.}$
			For 100 volt lamps 4.66 watts per c. p.	$M = \frac{\text{T. c. p.} \times D}{V}$	$T = \frac{D^2 \times \text{T. c. p.}}{V \times 16{,}000{,}000.}$	$\$ = \frac{D^2 \times \text{T. c. p.} \times L}{V \times 16{,}000{,}000.}$
			For 110 volt 3.1 watt lamps.	$M = \frac{\text{T. c. p.} \times D \times 2}{3 \times V}$	$T = \frac{D^2 \times \text{T. c. p.}}{V \times 24{,}000{,}000.}$	$\$ = \frac{D^2 \times \text{T. c. p.} \times L}{V \times 24{,}000{,}000.}$
		Three Wire System.	General Cases.	¼ of corresponding 2 wire case.	⅓ of corresponding 2 wire case.	⅓ of corresponding 2 wire case.
			For 100 volt 4.66 watt lamps.			
			For 110 volt 3.1 watt lamps.			
	For any case.			$M = \frac{C \times D \times 21.5}{V}$	$T = \frac{C \times D^2}{V \times 746.0}$	$\$ = \frac{C \times D^2 \times L}{V \times 746{,}000.}$
	For power at motor pulley.			$M = \frac{D \times \text{h. p.} \times 1{,}600}{V \times e \times P}$	$T = \frac{D^2 \times \text{h. p.}}{V \times e \times 10 \times P}$	$\$ = \frac{D^2 \times \text{h. p.} \times L}{V \times e \times 1{,}000 \times P}$
	For minimum total initial cost of plant.					$\frac{G \times E \times V}{(E - V)^2} = \frac{G \times p \times 100}{(100 - p)^2} =$ Dollars per h. p. del. by conductor.
Generators for minimum total initial cost of plant.						$\frac{100\ G}{100 - p} =$ Dollars per h. p. delivered by conductor.

Conductors as determined by safe heating.	Bare Copper Wire.	15° C.	$M = C^{\frac{4}{3}} \times 200.$
		35° C.	$M = C^{\frac{4}{3}} \times 170.$
		45° C.	$M = C^{\frac{4}{3}} \times 100.$
	Average Insulated Copper Wire.	15° C.	$M = C^{\frac{4}{3}} \times 150.$
		35° C.	$M = C^{\frac{4}{3}} \times 100.$
	Bare Iron Wire.	45° C.	$M = C^{\frac{4}{3}} \times 328.$
	Bare German Silver Wire.	45° C.	$M = C^{\frac{4}{3}} \times 608.$

E = E. M. F. of generator in volts.
e = " " device "
C = current in amperes.
c. p. = candle power of lamps at normal E. M. F.
T. c. p. = total candle power of lamps.
C. h. p. = candle power per electrical horse-power at normal E. M. F.
M = area of cross-section of wire in circular mils.
D = mean distance current is transmitted one way.
V = loss of E. M. F. in conductor (in volts).
$\$$ = cost in dollars.
L = cost of copper per pound in cents.
W = watts per candle-power.
T = weight of wire in pounds.
P = efficiency of device.
p = percentage loss in conductors.
G = cost of generator per h. p. delivered by conductor.

With the electric drill the motion is free from any jar due to the reciprocating engines heretofore employed, as there are no reciprocating parts, and the speed can be made absolutely constant under any condition of load up to the full load. The weight of the electric diamond drill is, for the same power, much less than that of the steam diamond drill and the space occupied is in a direct line with the hole and is extremely small in amount.

The drill can be operated from any existing electric light circuit and the current for it can be supplied at two miles' distance from the source of power by wires of size No. 10 B. W. G. having a diameter of about ⅛ of an inch. The drill can be carried wherever a man can carry 85 pounds, which is the weight of the heaviest single piece, and hence can be set up and operated in the most inaccessible places. It will be evident that for prospecting work, when a certain territory is to be explored, this drill is particularly adapted, as for operating at a distance of one mile in any direction the diameter of the wire neccessary is but 1/10 of an inch and the total weight of the wire only 340 pounds.

The Edison General Electric Company have a third kind of drill which is a rotary high speed drill, having a solid steel bit, and this drill is used for drilling coal and similar comparatively soft materials, and also for drilling metals where it will have an extensive use in the construction of steel ships and bridges and similar works where the drill has to be taken to the work rather, than the reverse.

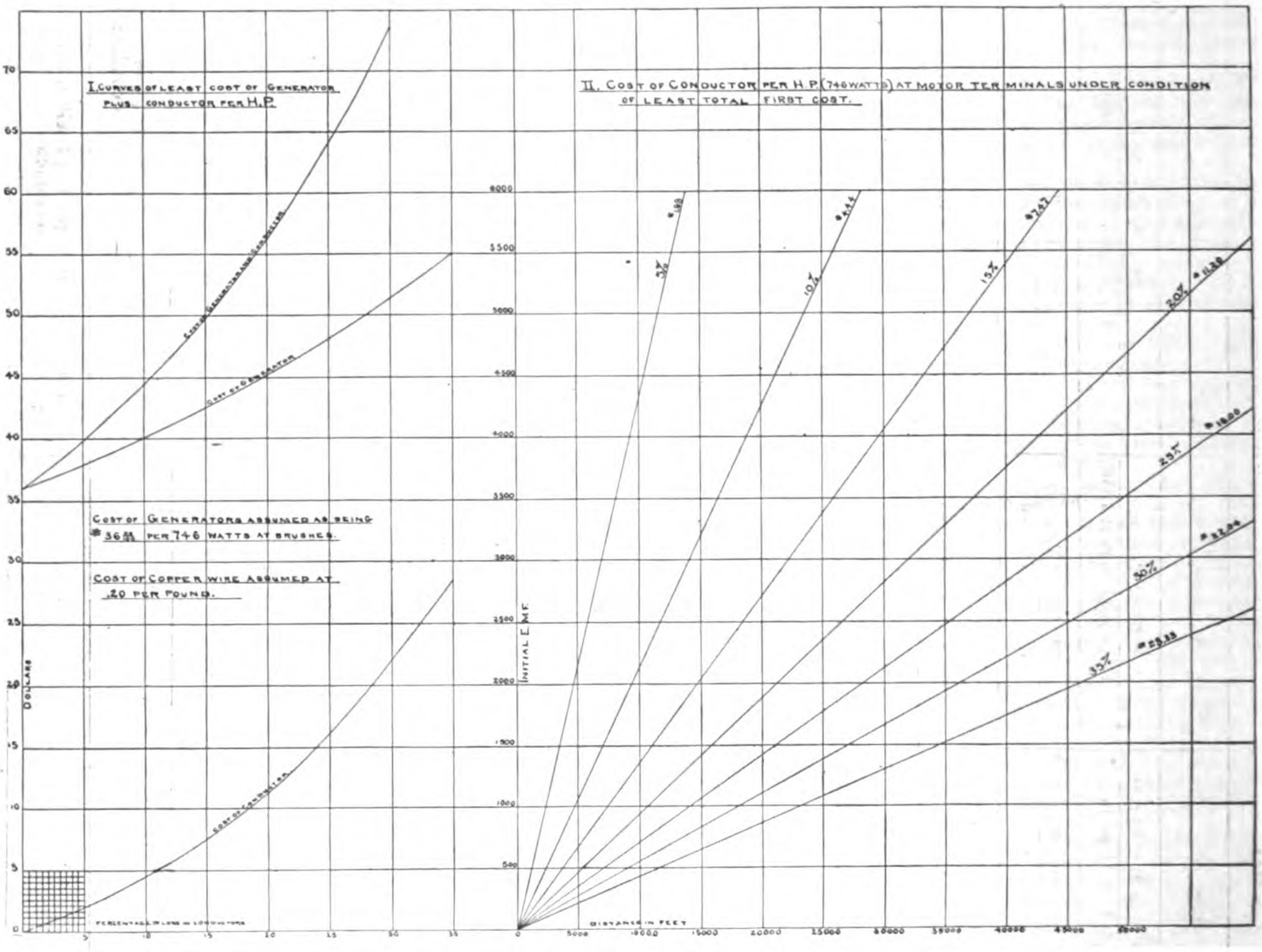


Fig. 2.—Curves Showing Least Total First Cost of Generators and Conductors.

The electric mine locomotive, and the hoists, pumps, ventilating fans, crushes, stamps, and so forth, operated by electricity are instances of the application of electricity to mining which have already proved themselves entirely successful. The under-cutting of coal by electricity is an important field in which the Edison company has made great strides, the machines being of two entirely distinct types, which becomes necessary in order to properly comply with the conditions met with in practice in different mines.

The electric refining of metals, especially of copper, is an extremely interesting subject to the mining engineer. The Edison Company have established the majority of the plants of this nature in the United States; and I need only say that the results are highly economical and most satisfactory in every way.

The electrical transmission and conversion of energy at great distances is destined to come up in nearly every mining problem in the future. Mines are usually in a mountainous country, and it is seldom that a water-power cannot be found within a few miles of a mine. The mining engineer in the immediate future will develop this water-power, convert its energy into electric energy, in which shape he will transmit it to the distant mine, when it will be again converted into the various forms of energy which he may have occasion to require.

Among the applications will be the following:

1. The lighting of the mines and the buildings and grounds by arc and incandescent lamps; 2. The operation of any machinery in the mill, such as crushers, stamps, and so forth; 3. The operation of the drills; 4. Hoists; 5. Pumps; 6. Ventilating fans; 7. The operation of an electric tramway in the mine; 8. The heating of the buildings when fuel is scarce; 9. The refining of copper and recovery of gold and silver in certain cases; 10. The concentration of magnetic ores in certain cases, such as iron, nickel, etc.

In order to give you a commercial idea of a plant, such as is likely to be used in mining operation in the immediate future, I will suppose a case and give you an estimate of the first cost and operating expenses of such a plant. Let us suppose that we have a mine where we have to operate the following devices:

360 incandescent lamps at 16 c. p. each; 10 arc lights; 1 hoist requiring 30 h. p.; 1 pump requiring 20 h. p.; 6 percussion drills for drilling 1½ inch holes at the rate of 3 inches per minute; 3 rotary diamond drills 1¼ hole, ¾ core, rate 2 inches per minute; 1 mine locomotive 10 h. p.; milling machinery requiring 30 h. p.; heating requiring 10 h. p.

The total power required for the above will be 180 h. p., delivered by the main motors. Suppose that at a distance of three miles there is a good water power which can be developed and equipped with water wheels to produce 300 h. p. by an expenditure of $15,000. In considering transmission of the power by electricity we must first determine what loss we shall sustain in transmission, and then we must determine what electrical pressure we will operate with.

In designing such a plant there are certain fixed laws governing the conditions of highest economy and minimum first cost; and some years ago I investigated these questions and produced formulæ expressing these laws. These formulæ are given in tabular form in the accompanying résumé, Fig. 1. I have also expressed the laws governing the conditions of minimum initial cost graphically in the diagram, Fig. 2.

It may be interesting to note here in passing, a fact which you will observe by examining the formulæ given, namely: If we pay proper attention to the laws governing the highest efficiency and the least first cost, the cost of the conductors for the plant will depend solely upon the initial E. M. F. and the distance. Thus, under practical conditions to-day, if we are to operate with 2,000 volts E. M. F. at a distance of 5 miles, the minimum first cost would be realized when we operate with a loss of 20 per cent. in conductors. The cost of copper (at 20 c. per lb.) for each horse-power delivered at the motor brushes under these conditions would be $7.47. This simple but invariable law which is embodied in the formulæ given herewith, you will find of great assistance to you in considering questions of electrical transmission.

You will also notice that the formulæ show that, for any given percentage of loss, the electrical pressure to be employed will vary directly with the distance. Thus, for 20 per cent. loss the cost of copper being $11.20 per horse-power delivered at motor brushes, the E. M. F. necessary for transmission of 16,000 feet will be 1,500 volts; at 32,000 feet we should use 3,000 volts, and at 8,000 feet, 750 volts. In order to secure the 160 h. p. necessary at our various devices in and about the mine, we must deliver 200 h. p. to our main motor in the form of electric energy in the conductor at the brushes of the motor. With 25 per cent. loss in conductors this will mean 266 h. p. at the generator brushes, or 300 h. p. delivered by the water wheels.

For the sake of reliability and economy we will use two generators instead of one, each being of 133 h. p. At the mine there will be two main motors of 90 h. p. each, wound for 900 volts and 83 amperes, producing a total of 180 h. p. which will drive the drill generator at 17 h. p., and a generator of 250 volts and 300 amperes for operating the incandescent lamps, the arc lamps, the locomotive, the hoist, the pump, the diamond drills and the heating. The main motors will also supply the milling machinery with the necessary 30 h. p.

By formulæ on Fig. 1, we find that to transmit 180 h. p. three miles, with 25 per cent. loss and an initial pressure of 1,200 volts, there will be required a wire having a circular millage of 190,000 circular mils; this wire has a diameter of 436 thousandths of an inch, or a little less than half an inch. We find that by other formulæ on Fig. 1 that the copper will weigh 20,000 lbs. and will cost $4,000, which results check each other and prove the accuracy of the calculation.

We are now able to make an estimate for the total plant, as follows:

Estimate of cost of plant for transmitting 180 h. p. a distance of three miles with a loss of 25 per cent. in conductors, the plant to comprise the apparatus as specified:

Developing original water-power and installing water wheels of 390 h p.	$15,000
2 generators 100 KW. each (1,200 v.—83 amp. each) at $36 per KW.	7.200
2 motors 75 KW. each (900 v.—83 amp), at $36 per KW.	5,400
Copper, 32,000 feet, No. 000, B. W. G.	4,000
1 6 drill generator.	2,000
1 generator of 250 v. 300 amp. 75 KW. at $36.	2,700
6 electric percussion drills.	3,300
2 electric diamond drills.	1,100
360 incandescent lamps and appliances.	360
10 arc Lamps.	220
1 30 KW. hoist.	2,255
1 20 KW. pump.	1.595
1 10 KW. locomotive.	1,815
Heaters, 10 KW.	600
Conductors for all secondary transmissions.	1,000
Labor of installation.	3,000
Poles.	455
Freight, cartage, and sundry expenses.	1.000
Total.	$53.000

The operating expenses of such a plant will be those mainly due to the wages of the men for each shift, one at the water-power and one at the mine. A fair allowance for depreciation and repairs will be 5 per cent. per annum of the first cost.

The operating expenses will therefore be about as follows:

1 First operator	$ 900	per year.
1 Second operator.	600	"
Depreciation and repairs 5 per cent. on $53,000.	2,650	
Sundry incidental expenses.	250	
	$4.400	

The production of the same power by steam, when coal is $2 per ton, and labor such that an engineer's wages are $2 per day, would be not less than double this amount; and in many instances where water and fuel suitable for the generation of steam are difficult to obtain, such a plant would represent a saving of its entire first cost every year.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Further arrangements have been made for the annual meeting in this city, by the local committee, which consists of Messrs. Foster, Caldwell, Thorburn Reid, and Binney. The regular meetings will be held at the house of the Institute, 12 West Thirty-first, where a collation will be served between the morning and afternoon sessions on May 20 and 21. The Wednesday evening session will be held in Prof. Dwight's room at Columbia College, 49th street and Madison avenue, at 8.30 P. M. A lecture will be delivered by Mr. Nikola Tesla, on "Experiments with alternating currents of high frequency." This will be illustrated by practical experiments with special apparatus devised for the occasion. Ladies are invited to attend this lecture.

The Electric Club has courteously extended to the Institute the full privileges of the club house, 17 East Twenty-second street, during the period of the meetings. Thursday, May 21, at 8 P. M., a reception will be tendered to the Institute at the club house. Special interest will be given to this reception by reason of the fact that the entertainment committee of the club has arranged for a loan exhibition of early electrical books, apparatus, models and paintings.

An official invitation has been extended to the Institute to be represented at the Electrical Congress of the Frankfort Exhibition. It is expected that delegates will be appointed and instructed accordingly.

There is every indication that the meeting will be one of the largest and most successful enjoyed by the Institute.

FRANKLIN EXPERIMENTAL CLUB.

The Franklin Experimental Club, of Newark, N. J., held its thirty-first regular meeting at the Club Laboratory, Tuesday evening, May 5th. The president, Mr. Wm. J. Hammer, read a highly instructive paper entitled "The Arc Light." As illustrating the rapid development of this industry, the speaker instanced the fact that while there was exhibited at the Centennial Exposition in Philadelphia, in 1876, but a single arc system, the Wallace, now arc lamps are burning everywhere and are numbered by the thousand and the hundreds of thousands. Mr. Hammer summed up the problems confronting the arc light men and spoke of the field for invention in alternate current lights. The paper was illustrated by diagrams prepared and mounted for the occasion.

Mr. F. M. Crane spoke on electric rail roads. He compared the three systems which are striving for supremacy in this field: the trolley, the storage, and the conduit.

At the next meeting, May 19th, Prof. Geo. C. Sonn will deliver a paper on the phenomena of earthquakes, and will illustrate with lantern slides. Mr. Earl Atkinson will speak on motors.

At the first meeting in June, it is expected that Mr. Nikola Tesla will address the club.

College Notes.

CORNELL UNIVERSITY.

Mr. Frank C. Perkins, electrical engineer, 209 Central avenue, Dunkirk, N. Y., has just issued a charming and most interesting book entitled "Cornell University: Her General and Technical Courses." It is in oblong form, with heavy ornamental board covers, and is profusely illustrated with views of the famous University, and portraits of the various professors and instructors. Mr. Perkins has done his work with intelligence and taste, and there is not anyone who, if interested in Cornell, will not be delighted to possess a copy of this brochure. We are glad to note excellent portraits of Profs. Nichols, Moler, and Ryan, of the electrical department.

FARMING vs. ELECTRICITY.

The following pathetic little bit of correspondence between two of the "old timers" in the electric railway business recently fell into our hands: "Looking over the figures bid on a recent large contract—don't you think that veterans, like you and me, had better quit and go farming?" There is a depth of feeling in this that many can appreciate, but it is devoutly to be hoped that these two mourners will still stick to a field in which they have both greatly distinguished themselves—many a time. Should they become farmers, we are sorry for the Alliance. It will be the liveliest third party this country has ever seen.

THE STEWART CONDUIT FOR ELECTRIC RAILWAYS.

BY R. A. STEWART, PITTSBURGH, PA.

Considering the attention that is being given to underground conduits for electric railways, and the persistently continued objections to the unsightly, if not dangerous, poles and overhead wires, it is evident that underground conduits are destined to become a prominent feature of electric railway work. But objections have been found with underground conduits as heretofore constructed, principally to the open or vertical slot, in which horses' shoes and narrow tired vehicles are alike liable to be caught, and into which the water and refuse of the street flow freely. The main, practical objection, however, has been to the expensive construction necessary in a conduit which forms no part of the tracks but which must be built of itself. To overcome these objections I have had patented a conduit which is a part of the tracks and which has a protected side slot. In the accompanying cuts Figs. 1 and 2, one form of construction is shown.

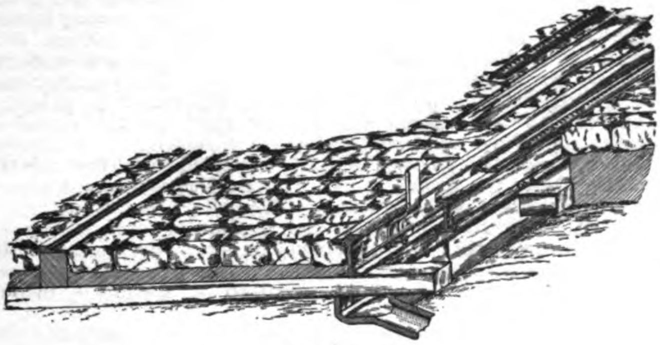


FIG. 1.

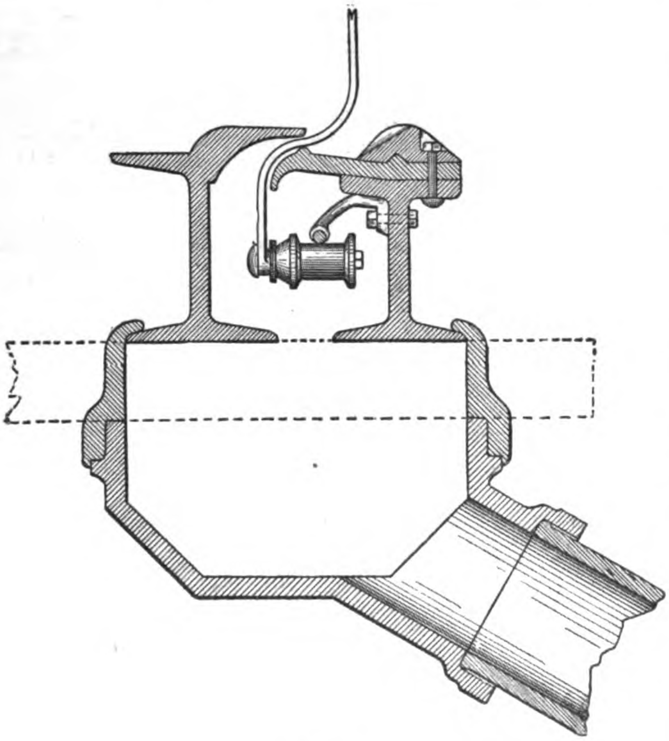


FIG. 2.

The rail on which the car wheel runs forms one side of the conduit. The other side is formed by a girder rail on which is a detachable tread and ribbed faced rail. This supplementary tread rail is overlapped by the main tread rail, forming a slot between them extending sidewise into the conduit. Horses cannot catch their shoes in this side slot and very little if any mud or water will pass through it into the conduit.

The supplementary tread rail slopes away from the slot to the ribbed-faced rail, forming a trough which carries the mud or water away from the slot and out through deep indentations in the ribbed faced rail to the street.

This trough will also take the wagon wheels and thus relieve the main rail of any undue pressure, the ribbed faced rail allowing the wheel to catch and turn off quickly and without sliding.

Any mud or water that could get into the conduit will be carried off by the drain at the bottom, which is made of tiling and is connected at intervals with the sewer.

A depending lip on the supplementary tread rail extends over and protects the electric conductor from outside interference and also prevents any drippings through the slot from lodging on the conductor, whether the conductor be hung for underrunning or overrunning contact, either of which is allowable.

A particular advantage of this conduit over others, is the ease with which access can be had to it for inspection or repairs. By simply detaching the supplementary and ribbed-faced rails, free access is obtained into the conduit without interfering whatever with the running of the cars or with the street traffic.

The cost of construction which has been a drawback to most underground conduits is a decided advantage to this one. The car track forming one side of the conduit, it only requires the additional expense of the one other side, and it is evident that this will be far less than a conduit necessarily built of itself and forming no part of the tracks on which the cars must run.

Reports of Companies.

WESTINGHOUSE ELECTRIC AND MFG. CO.

The annual meeting of the stockholders of the Westinghouse Electric and Manufacturing Company, in accordance with the by-laws of the organization, was called for Monday, May 4th, 1891. A good deal of interest was of course felt by the local stockholders of the company in this meeting and it was looked forward to with some anxiety. The expectation was that Mr. Westinghouse would give in detail the result of his negotiations made during the last few months with the view of putting his company upon a good basis financially. At the meeting, fifty stockholders were present. Mr. Westinghouse presided and after the formal opening of the meeting, the following statement was read by him:

"The annual meeting of the stockholders of this company was called for this day in compliance with the by-laws, which fix this day for the day of the annual meeting. The directors at a meeting held this morning, passed the following resolution: 'It is moved that in view of the fact that in the opinion of this board it is not advisable to announce at this time the details of the plan for placing the preferred stock of this company, liquidating its floating debt and securing working capital which has been substantially completed, the stockholders be requested to adjourn the annual meeting called for to-day to Monday, May 18th, 1891, at 10 o'clock in the forenoon, in room 64, Westinghouse Building, Pittsburg, Pa.' In the negotiations, which have been so nearly concluded, the interests of the present stockholders have received special consideration, with a view of giving a permanent value to their stock. The business of the company has been continued without interruption, and although with a lesser volume than for the same period last year, the net results have been better. The orders in hand and those being received are equal to the capacity of the works, and it is expected that the arrangements which have been made will soon put the works of the company in full operation. A large reduction in expenses has been effected, by reason of which, and a more conservative business policy, the affairs of the company have been steadily improving since the first of January."

Upon the request of Mr. Westinghouse, after the reading of this statement, Mr. Frank Whitesell, a Pittsburgh lawyer, moved that the meeting adjourn until Monday, May 18th, at 10 o'clock, A. M. This resolution was passed unanimously.

To the above it may be added that a syndicate, consisting of August Belmont & Co. of New York; Lee, Higginson & Co. of Boston, and Brayton Ives, President of the Western National Bank, has been formed to undertake the reorganization of the Westinghouse Electric and Manufacturing Company and its associated interests. This syndicate, together with certain creditors of the company and others, has agreed to take $3,000,000 of 7 per cent. preferred stock upon the assent of the stockholders to the plan of reorganization.

Messrs. August Belmont, Marcellus Hartley, Henry B. Hyde, and Brayton Ives, of New York, and Charles Francis Adams and Charles Fairchild (of Lee, Higginson & Co.,) of Boston have consented to become directors.

According to the plan the $100,00,000 capital is not to be increased. The holders of the $7,000,000 common stock outstanding are to surrender into the treasury 40 per cent. of their holdings, which, with the $3,000,000 issued but not sold will make about

$6,000,000 of treasury stock. Of this $4,000,000 is to be converted into 7 per cent. stock, of which the $3,000,000 specified above is to be issued to care for the floating debt and provide working capital, and $500,000 is to be held in the treasury to provide further capital when neeeed. A part of the remaining treasury stock is to be used to purchase further stock in the United States Electric Lighting Company and the Consolidated Electric Light Company, in both of which companies the Westinghouse Company is already interested.

It is understood that this plan not only meets with the approval of the directors and the bankers, but has also been examined and approved by prominent stockholders and creditors.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 5, 1891.

Accumulators:—

Secondary Battery, G. A. Washburn, 451,540. Filed July 23, 1890.
Includes an insulating casing for the cells having a cup-lining of conducting material, an inner wall of conducting material apart from said lining, and active material between said wall and lining, and a battery element centrally placed within the case.

Secondary Battery, G. A. Washburn, 451,541. Filed Oct. 24, 1890.
Includes a porous cup containing hollow compressible conductors, an electrode outside of the cup formed of opposed conducting-plates, and active material between the outside plates and in the porous cup.

Secondary Battery, T. H. Aldrich, 451,445. Filed Dec. 27, 1890.
The electrode consists of a body of active material formed with an aperture adapted to receive a conducting plate, and a conducting-plate taking loosely into the body of active material.

Alarms and Signals:—

Multiple Signal Transmitter, B J. Noyes, 451,512. Filed Sept. 22, 1890.
Combines a train and a let-off with a removable signal-wheel and means controlled by the signal-wheel for moving the let-off.

Temperature Alarm, L. Zagelmeyer, 451,543. Filed Dec. 8, 1890.
A thermostatic device including a thermometer.

Alarm Signal, M. A. O'Donnell, 451,639. Filed Mar. 17, 1890.
Permits a policeman to use his club upon the signal box rather than upon his prisoner. Device in the handle of the club for operating signal box.

Signal Box, M. G. Davis, 451,689. Filed June 18, 189.
Improvement upon the signal box patented to M. Martin, Dec. 20, 1887, No. 375,083.

Fire Alarm Telegraph Apparatus, J. W. Stover, 451,902. Filed Jan. 23, 1888.
A non-interference signal box.

Conductors, Conduits and Insulators:—

Insulated Electric Conductor, J. B. Williams, 451,586. Filed July 12, 1890.
A device to keep the conductors concentric with the dielectric employed as an insulator when the latter is of a nature to be readily softened by heat. Consists in a support for the conductor composed of fibrous material saturated with an insulating material not so readily softened by heat as the dielectric.

Insulated Electric Conductor, J. B. Williams, 451,587 Filed Nov. 13, 1890.
For the same purpose as the next above. Differs in detail.

Electric Conductor, J. D. F. Andrews, 451,605. Filed Oct. 31, 1890.
Relates to cables combining a direct and return circuit, and is designed to secure a water tight protection and to afford facilities for joints and connections at desired points without impairing the insulation.

Underground Electric Wire Conduit, H. B. Cobb, 451,614. Filed April 29, 1890.
Employs supports spacing the conductors and secured to the conductors independently of the walls of the conduit, the supports being provided at intervals along the conductor and being movably supported in the conduit. Includes also devices for house connections from the conduit at desired points.

Dynamos and Motors:—

Dynamo Electric Machine, L. C. Rice, 451,574. Filed May 14, 1890.
Relates to alternate current machines. Details of design and construction of field magnets and armature intended to increase efficiency and to facilitate repairs.

Electric Motor, W. E. Hyer, 451,559. Filed Nov. 26, 1890.
The field-magnet has a single coil surrounding the armature and located in a plane oblique to the armature shaft; the magnetic circuit is composed of two hollow castings bolted together on a plane including the armature shaft.

Dynamo Electric Machine, L. N. P. Poland, 451,700. Filed May 7, 1888.
A construction designed to save space and to secure better ventilation. Includes also a regulating device.

Method of Operating Reciprocating Electric Engines, C. J. Van Depoele, 451,786. Filed Jan. 3, 1891.
Consists broadly in employing one set of coils adapted to be energized by an intermittent direct current and another set of coils energized by alternating currents having a defined rise and fall.

Electric Motor, E. M. G. Hewett, 451,870. Filed Nov. 14, 1890.
A motor of the type in which a series of electro-magnets surround an armature composed of bars of soft iron.

Electric Motor, F. M. LaBolteaux, 451,872. Filed June 4, 1890.
Details of construction for small motors and for mounting them to drive fans or other mechanism.

Electric Motor or Dynamo Electric Machine, S. S. Wheeler, 451,884. Filed April 23, 1890.
In a ring armature the core is formed with trapezoidal slots or openings in its periphery; the coils or windings laid in the slots and passing through the inside of the ring form trapezoidal shaped coils or sections which fill the slots in the periphery and in the inside of the ring fit against each other and fill the interior, the coils being thus made symmetrical with respect to the outside and inside of the ring.

Method of Constructing Field-Magnets of Electric Motors, S. S. Wheeler, 451,885. Filed Sept. 13, 1890.
Consists in boring the yoke or base and trimming the ends of the field forgings with reference to the centre of their concave parts.

Electric Motor or Dynamo Electric Machine, W. F. Collins, 451,894. Filed April 17, 1888.
Similar to the next above, but does not show ring windings. Claim follows:
An armature core for an electric motor or dynamo-electric machine formed with trapezoidal slots in its periphery of greater width at the bottom than at the top, the windings or conductors being contained in the slots
Designed to secure a minimum amount of magnetic resistance between the armature and the field-magnet cores and to diminish the evil effects of centrifugal force upon the armature windings.

Lamps and Appurtenances:—

Socket for Incandescent Lamps, S. Deacon and M. J. Wightman, 451,656. Filed March 15, 1890.
Relates to details of the circuit-breaking switch in the lamp circuit.

Current Regulator for Electric Lamps, C. H. Balsley, Jr., and E. M. Porter, 451,798. Filed Jan. 17, 1891.
A current regulator adapted to be inserted in the socket of an incandescent lamp. Consists essentially of a rheostat composed of graphite rods and means for inserting them in circuit.

Measurement:—

Electric Meter, E. W. Rice, Jr., 451,590. Filed March 8, 1889.
Designed for use with currents of any character, continuous, alternating, or intermittent. Employs the heating effect of a current upon a pair of expansible bars, so mounted that neither shall be heated by radiation or conduction from the other, switching devices for heating the bars in turn, and means for registering the movement of the bars under expansion.

Miscellaneous:—

Combined Switch and Lightning Arrester, E. W. Rice, Jr., 451,591. Filed March 5, 1890.
Particularly for use on electric cars. Combines with a manual circuit-breaking switch a blow-out magnet having poles adjacent to the contact points of the switch, and a supplementary lightning arresting contact adjacent to the poles of the magnet and connected to ground.

Magnetic Attachment for Windows, T. N. Sterry, 451,606. Filed July 2, 1890.
A device for holding window sashes firmly in position and to prevent rattling.

Electric Stop Motion, C. A. Dayton, 451,649. Filed April 21, 1890.
Applicable to stationary steam engines, and intended for use in connection with the speed-governor and to enable an engine to be stopped from a distant point.

Railways and Appliances:—

Electric Brake, J. M. Payne, 451,514. Filed March 31, 1890.
An electro-mechanical car brake.

Electric Railway Truck, W. H. Knight, 451,491. Filed Feb. 15, 1890.
Two electric motors mounted upon the two axles of a truck have inward extensions flexibly united at their inner ends to permit freedom of radial adjustment of the axles.

Electric Railway System, C. K. Harding, 451,637. Filed Oct. 27, 1890.
Combines an insulated main conductor, a series of stationary main conductor contacts, protected in insulated cups, with electric cars having current collectors carried thereunder, and a movable circuit-completing device normally insulated from the main supply conductor but adapted, when actuated, to make contact with the main conductor.

Mechanism for Carrying Trolley-Wheels Underground, J. Holland, 451,691. Filed Dec. 22, 1890.
A device for avoiding a continuously-open slot in conduit electric railways. The conduit is closed by a series of doors, hinged at opposite sides of the conduit and meeting in the centre; the trolley carrier is adapted to open the doors successively sufficiently to permit its passage through the conduit.

Electric Railway, R. M. Hunter, 451,692. Filed Apr. 28, 1888.
Relates to a system of switches for a main line of an electric railway with sidings and out-going and in-coming branches, all of which may be used at one and the same time.

Switch for Overhead Electric Conductors, J. Kuehnle, 451,696. Filed Dec. 18, 1890.
A switch or "frog" for use at a junction of one trolley wire with two others.

Electric Car Lighting Apparatus, B. J. Jones, 451,782. Filed Oct. 7, 1890.
A lighting apparatus for street cars. When the head-light is placed in position it automatically switches out the platform lamp at its end of the car, dispensing with the use of independent switches for that purpose.

Conduit System for Electric Railways, W. H. Ford, 451,815. Filed Oct. 8, 1890.
A bare conductor is made up in sections of a predetermined length; two mechanical contact devices or trolleys are fixed upon a vehicle at a greater distance apart than the length of a single section of the bare conductor; one of the trolleys is for electrical contact and the other is for the mechanical work of connecting and disconnecting with each section of the conductor successively.

Telegraphs:—

Telegraph Repeater, A. C. Booth, 451,449. Filed Aug. 24, 1889.
An automatic repeater for Morse circuits.

Telephones and Apparatus:—

Telephone Receiver, W. S. Corwin, 451,634. Filed Nov. 30, 1888.
Combines a permanently magnetized steel casing or tube, forming the handle, and a soft iron core or centre rod, insulated from the case at its rear end, with a diaphragm and bobbin or electro-magnet of the usual construction.

MINNEAPOLIS, MINN.—In the $15,000 damage suit of August Johnson again the Northwestern Telephone Exchange Company, Judge Smith directed the jury to return a verdict for the defendant, holding that the company was not responsible for the damage caused by the falling of the wire-laden pole, when some one, not connected with the company, had cut the guy ropes holding it in place. The case will probably be appealed.

Literature.

Decorative Electricity. By Mrs. J. E. H. Gordon. *Chas. Scribner's Sons.* New York, 1891. Illus. 178 pages, 9 x 5¾. Price, $3.75.

A MOST original and attractive book is this, written with an enthusiasm in behalf of the electric light that is most delightful and refreshing. Mrs. Gordon not only has all the pioneer spirit of her well-known husband, but positively "goes him one better." She has seen at a glance how many are the new opportunities for effective interior illumination afforded by the electric light, and has in an exceedingly clever and thorough manner worked all these possibilities out in practice. Each part of the modern House Beautiful, or of Philistine Villa, is taken, and all its requirements in the matter of light are dealt with in detail. Mrs. Gordon tells of her own experience in getting just what she wanted, and the book abounds in shrewd hints and suggestions. Thus we have methods worked out for a newspaper table with lamp; a summer fireplace with electric lights; bed reading lamp; kitchen grate light, as well as the more ordinary and commonplace lights for the living rooms, library, bath room, etc. If Mrs. Gordon's ideas were carried out, the perfection of lighting in our parlors and dining rooms would be reached. We should be conscious of agreeable illumination, but never find the lamps obtrusive.

We could heartily wish that this book, with its admirable two-score illustrations by Mr. Herbert Fell, might find its way into the hands not only of our designers of glassware and fixtures for electric lighting, but of every central station manager who has begun to supply lights for residences. It is a book that any superintendent can read with direct benefit, while he could not possibly put it in a customer's hands without experiencing an indirect but very substantial addition to the demand for current.

When Mrs. Gordon gets out her next edition, as she soon will, if we have not greatly misjudged the need existing for such a book, she may find it worth while to extend its scope and include other details to which the word "decorative" could hardly apply. Thus, in one instance a sleepless friend of ours has an arrangement by which he can light up the face of a clock at any moment during the weary hours of the night. In another instance the little lamp has been turned into a very comforting foot warmer for the bed. Mrs. Gordon makes incidental reference to electric hair curlers, but these are only one of a score of new devices in which electric heating begins to assume value and importance.

Mr. Gordon contributes a pithy little chapter on "Fire Risks," showing how safe the light is, properly installed. It is a great pity somebody did not add an index.

Electricity: The Science of the Nineteenth Century. By E. M. Caillaird. New York: *D. Appleton & Co.*, 1891. 7¼ x 5. 310 pages.

This is a modest book, and one for which there may not exist any very special need; but for all that it deserves commendation not only as being the work of a woman, but as a clear and intelligent exposition of the subject. In one sense it is popular, but the author has aimed, on every page, to be exact in phraseology and definition. The book is divided into four sections: Static Electricity; Magnetism; Current Electricity; Practical Appliances of Electricity, with a concluding chapter "What is Electricity?" and a "Note on the Polarization and Magnetization of Light." Each of the topics is handled with delicacy and sureness of touch, and the whole is interesting in style and treatment. Not the least merit of the book is that one is presented with the latest thought and theory in each branch of the subject. It has, moreover, enjoyed a revision by Prof. Ayrton, and has an index that will stand trial.

American Electrical Directory, 1891. Sixth year. *Star Iron Tower Co.*, Fort Wayne, Ind., 594 pages, cloth. Price, $5.

This sixth edition of a standard publication keeps up a high degree of merit and usefulness. It gives full data as to all the central stations and electric railway plants of the country, as well as those of Canada and Mexico. It also gives a list of the various manufacturing companies, in addition a list of all the State Electric Lighting Associations. Other sections contain the electrical societies and clubs of the country. A valuable feature also is that which contains the rules and requirements of the Boards of Fire Underwriters. In regard to all the companies and bodies, the names are given of all the officers, while there are full details as to the capitalization of each company and the nature of its central station, or electric railway equipment. Two other important sections are those devoted to insulated incandescent plants and to plants on steamboats.

In view of the diffiulties attendant upon the collection of matter of this kind, the amount of information furnished is remarkable, and its general accuracy is no less commendable. At the end of the book will be found the Philadelphia lighting schedule, and a number of tables and formulæ specially selected with an eye to the needs of station superintendents and managers. The book is well printed in bold type and strongly bound.

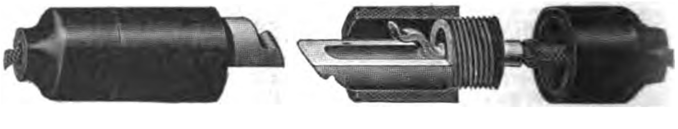
Patent Notes.

ELECTRIC RIVETING INTERFERENCE DECISION.
THOMSON vs. RIES.

A decision has been rendered by the Examiner of Interferences, in the United States Patent Office, in which priority of invention of the broad art of electric riveting and also of the apparatus for practicing this art, was awarded to Mr. Elias E. Ries of Baltimore, the other party to the interference being Prof. Elihu Thomson. The interferences just decided were two in number, the first being between the patent of Elihu Thomson, No. 396,015 dated January 8, 1889, for a method of electric riveting, and an application of Elias E. Ries, that was pending in the Patent Office at the time this patent was granted. The second interference was between a patent of Elias E. Ries, No. 403,374, granted May 14, 1889, and an application of Elihu Thomson filed June 14, 1889, for apparatus for electric riveting. As the records of the Patent Office show that Mr. Ries was the first to file his application for letters patent and that he had two applications. describing and claiming the inventions in controversy, awaiting official action at the time the Thomson patent was erroneously issued, Prof. Thomson was made the junior party in each interference. Testimony was taken by both parties, which showed that Mr. Ries was not only the first to file, but also the first to reduce the inventions to practice, and upon these and other facts brought out by the testimony the decisions awarding priority to Mr. Ries were based.

A NEW TRAILER CONNECTION.

THE devices commonly used for connecting the lighting circuits on the motor and tow-cars in electric railways, have projecting metal ends. As these are always connected to the circuits, a person standing on the ground or on a wet platform is apt to get an unpleasant shock by touching them. Most of the connections now on the market are, it is also claimed, much larger and heavier than their purpose demands.



A NEW TRAILER CONNECTION.

Our cut shows the new form designed by Mr. Chas. G. Armstrong, of Chicago, which has many good points. The two parts are interchangeable and the projecting metal tips are in circuit only when the whole is slipped together, when the parts are separated, these ends are dead and may be handled with safety even in wet weather The end of each conducting cord is soldered into a brass tube, and a knot in the cord takes all the strain off this joint. The contact surfaces are large and a stiff spring ensures a quick make and break. The insulating bushings, as well as the shell, is made of hard rubber, nicely finished. The whole is not much larger than the cut, and is well made throughout. George Cutter is putting it on the market.

NEW YORK CITY.—At the annual meeeting and election of the N. E. Telephone and Telegraph Co. the following officers were elected: President, Thomas Sherwin; vice-president, H. S. Hyde; secretary, D. W. Leedom; treasurer, W. R. Driver; executive committee, J. E. Hudson, M. G. Parker and Thomas Sherwin; general manager, J. W. Keller; auditor, S. W. Leedom; board of directors, F. Ayer, L. F. Beckwith, J. H. Cahill, J. P. Davis, B. C. Dean, W. H. Forbes. E. W. Beel, J. T. Hudson, H. S. Hyde, J. Jameson, J. Kavanagh, E. P. Meany, M. G. Parker, S. Salisbury, W. D. Sargent, and T. Sherwin. The report of 1890 shows the company's gross earnings, $1,383,667; expenses, $1,045,037; net earnings, $338,630.

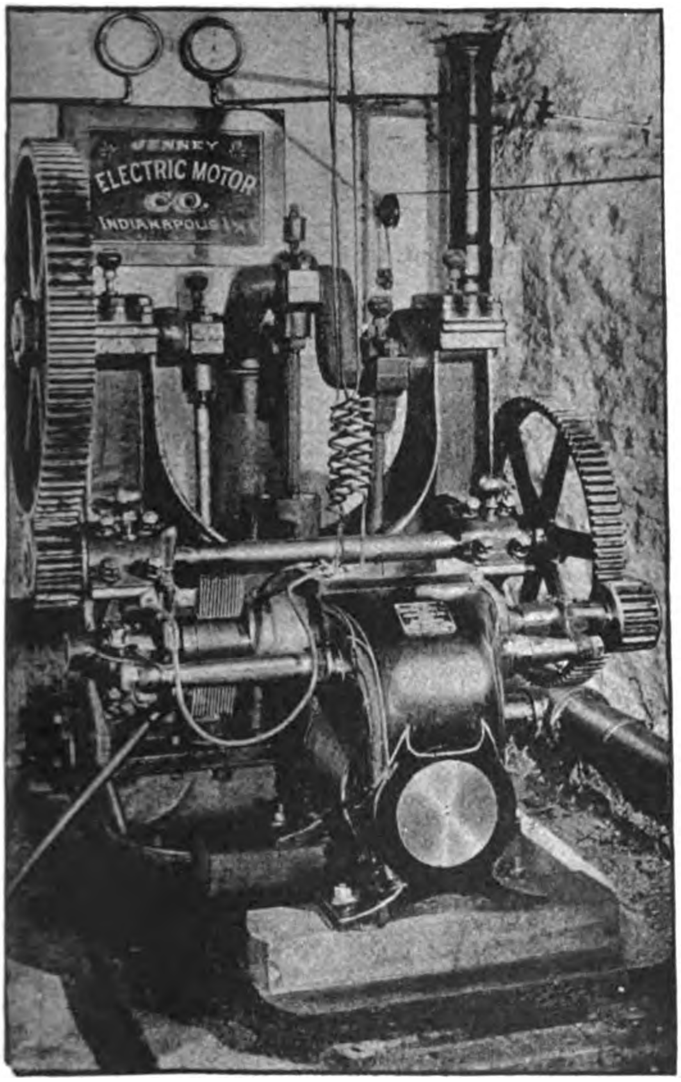
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Steady advertising and a growing trade go hand in hand.

"JENNEY" MOTOR APPLIED TO A HYDRAULIC PUMP.

An important application of the electric motor is that of pumping water, especially for operating hydraulic elevators. A notable instance of this kind is illustrated by the accompanying cut. A 7½ h. p. Jenney motor is shown geared to a Gould triplex pump at the Board of Trade Building, Indianapolis. City water had been used to operate the passenger elevator, but it was found that quite a saving in expense could be effected by sinking a well, putting in motor and pump in basement, and placing a tank on the roof.



Jenney Motor and Hydraulic Pump.

The combination has been working successfully for several months, furnishing ample water for the passenger elevator as well as for use throughout the building. The motor requires very little attention, and is much more desirable than a steam plant for the same work, as there is no heat, dust, noise, or danger of explosion. It is started and stopped automatically by means of a special switch which is operated by a float in the tank. The small pinions are of rawhide, and the bearings on motor are self-oiling.

These combinations apply equally well to roof or to pressure tanks, for elevator work, and are very effective for such work as draining of mines. The operation of this plant has been satisfactory from the start and is worthy of special notice on account of the very considerable saving in expense.

A REVOLUTION IN THE WIRE TRADE.

One of the most striking and important departures in the insulated wire business is that just made by the New York Insulated Wire Co. of 649-651 Broadway. It consists in nothing less than the opening of a large establishment of its own in Chicago, where a fine store has already been secured at 78, 80 and 82 Franklin street. The plan has been maturing quietly for some time, under the hands of secretary Gallaher and his associates, and the past month has witnessed some quiet, effective work in Chicago by President Place and Mr. J. W. Godfrey, the general manager. The company is the first concern of the kind in the country, we believe, to handle its trade in this manner, and thus meet purchasers as closely and promptly in Chicago, and the territory covered by that city, as if they were dealing direct with the New York house.

The new store which will be in readiness by May 20, is excellently situated with reference to the electrical industry of Chicago. It will have a fine suite of offices on the first floor fronting on Franklin street, and will occupy also the whole second floor. As this is 60 by 80 feet and is double decked, being very lofty, there will be available as much as 9,600 square feet of space on that floor alone. The store will carry a stock of about $100,000 worth of Grimshaw white core, "B. D.," "Competition" line wire, tapes, compounds, etc., and half the stock has already been shipped, the remainder following as quickly as possible.

In order that this store and its important trade shall be in the best hands, the Company have placed it in charge of Mr. G. H. Meeker, who has been associated with the rubber business for a great many years, and has ably represented the Company for a long time. He is well-known in Chicago. He will have with him a full corps of assistants, and leaves immediately to take charge of the Company's new interests in the West. As might be expected, the faint rumors that have circulated as to the intentions of the Company have excited no little curiosity, and it is beyond question that this full and explicit announcement of their plans will be received with the utmost interest wherever wire is sold and used in America. Such a step not only speaks volumes for the popularity of the Company's products but shows an inspiring confidence in the stability and growth of electrical business as a whole.

THE SHORT GEARLESS MOTOR.

Mr. C. C. Curtiss, of the Brush and Short companies, while visiting the offices of The Electrical Engineer last week, alluded to the remarkable popularity that the Short gearless motor enjoyed on the score of its noiselessness, and pointed out how this fact took the point out of nearly all the arguments of the people in Brooklyn, who have been objecting to the introduction of the trolley system.

A recent test of the gearless motor made on the private track of The Short Electric Railway Company and also in the streets of Cleveland has demonstrated its high efficiency. Although the E. M. F. of the line was low the current taken was very small considering the service to which the motor was put. On a level, and at a voltage of 400 to 450, the ampere readings ranged from 7 to 15. On severe grade and curve work the amperes ranged from 35 to 50. but with a voltage at times of less than 300, showing that the true ampere readings should not have exceeded 20 to 30. At the end of the long and rapid run the motor was almost stone cold, the heat developed being very small. The remarkable current efficiency of the gearless motor is due to the fact that the wire on both fields and armature is large and the counter E. M. F. is obtained by working up the intensity of the magnetic field to a very high point.

The "Gearless Motor," of the Short Electric Railway Company is in fact meeting with universal commendation. Already the first factory order is completely pledged, and the Short Company is on the point of closing large orders which will tax the capacity of their shops for a long time to come. The first gearless motor has now entered upon its eleventh week of service with a remarkable record. Although subjected to the severest tests—tests which can never come upon it in ordinary street railway service, there has not been one particle of trouble with it from beginning to end; neither armature or field coil has burned out; the motor runs perfectly cold with high efficiency, and pulls heavy loads over severe grades with entire ease. The motor has enormous reserve power, and it is practically impossible to burn it out. Motors of the first factory orders are beginning to come out and will be placed on regular service by May 15th, when the Short Company proposes to demonstrate to the world its ability to make an absolutely successful gearless motor, simple, efficient, and strong, perfectly protected, thoroughly reliable and "Standard" in street railway service.

The Short Electric Railway Co. have the services of Mr. Paul W. Bossart, and have now added Mr. R. C. Carhart to their forces.

The Mason Battery and Electric Co. has been incorporated at Newark, N. J., to manufacture electrical appliances, batteries, etc.

THE CROWDUS PRIMARY BATTERIES.

In a recent issue of The Electrical Engineer[1] we described the interesting construction of the cell adapted by Mr. Walter A. Crowdus, electrician of the Crowdus Chemical-Electric Company, of Memphis, Tenn., by which connection from one cell to another in a series was effected without carrying over conductors above the cells, an arrangement which is always troublesome and liable to cause short circuits. As described at that time, connection from cell to cell is made by permanent conductors carried in the lower compartment of the cell free from all disturbing influence.

The Crowdus Company are now manufacturing a series of such cells, one of which is illustrated in the accompanying engraving. The smallest of these, Type 4A, has a capacity of 120 watt hours and is designed for a normal discharging rate of 5 amperes at 5 volts pressure. The cell on open circuit gives 7½ volts and is capable of delivering 25 amperes on short circuit. Type B, has a capacity 140 watt hours, and type 4C, Fig. 1, of 190 watt hours with a normal discharge rate of 7 amperes at 5 volts.

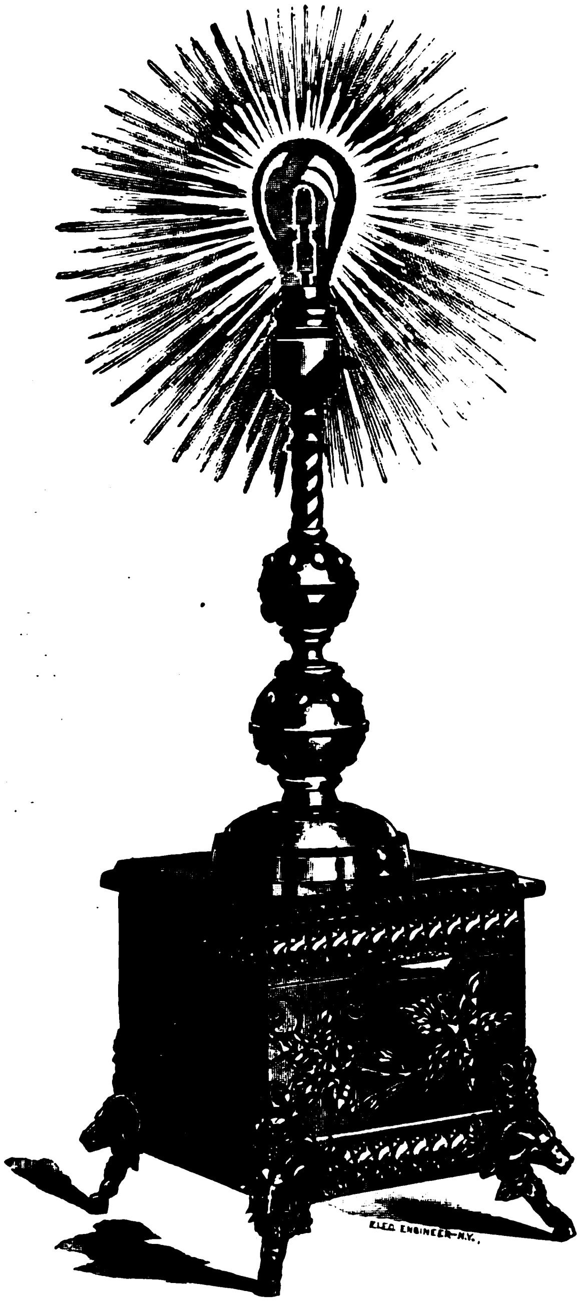

ELEC. ENGINEER-N.Y.

Fig. 2.—The Crowdus Ornamental Battery Lamp.

The positive element in the cell is zinc. The solution is composed of a mixture of 3 pints of water to 4 pints of sulphuric acid, mixed to saturation with nitrate of soda. The tops of the cells are covered by a rubber pan containing peroxide of manganese, which absorbs all the gases given off by the cell, so that its presence in a room is not objectionable. **The nitrate of soda is sent out in the shape of a white salt, which is added to the sulphuric acid solution in the manner stated above. These batteries are built for powerful and constant service and are not intended to remain on open circuit for any great length of time. Should they be required to do intermittent work, however, it is more economical** to use a solution of common salt with the zincs, in the place of acidulated water. These cells are built in a variety of sizes for a wide range of work, such as the lighting of table lamps, the driving of small motors, etc. A design of a table lamp is shown in Fig. 2, in which the battery is contained in the base of the lamp, the base being only 7 inches square.

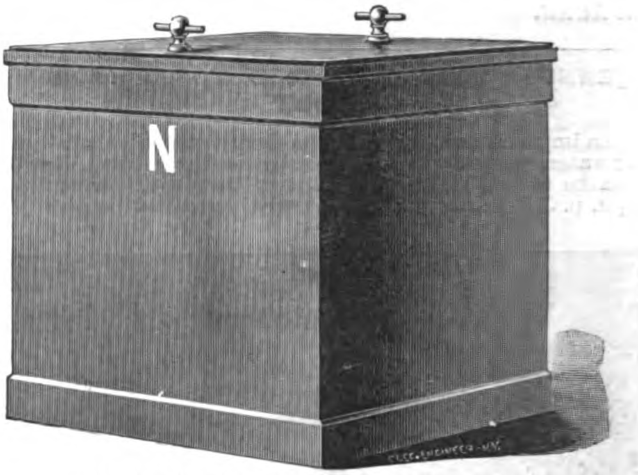
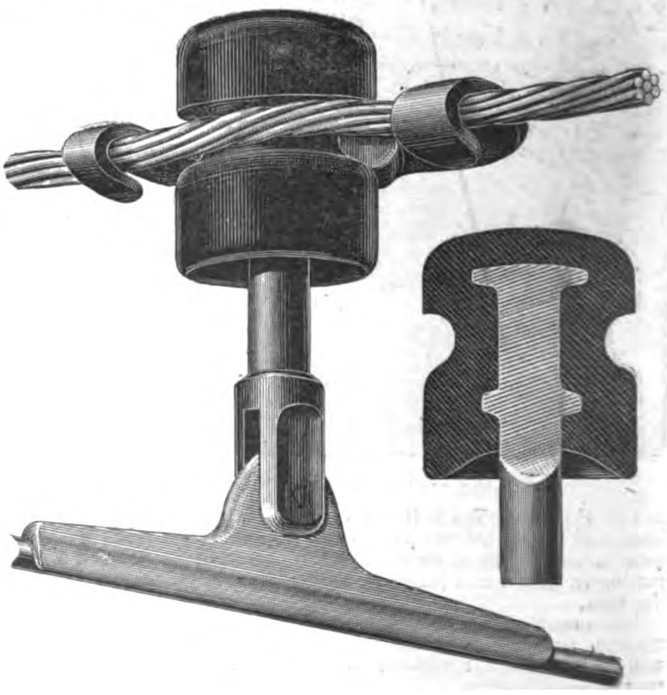


Fig. 1.—The Crowdus Primary Battery.

THE "CINCH" INSULATOR.

The "Cinch" trolley wire insulator, shown in the accompanying illustration, has many distinct advantages, which have won for it the unqualified approval of every practical man who has seen it. The insulating material is comb stock rubber, the stem and yoke are of malleable jet iron, and the pin is of brass. The strains on the insulating material are solely those of **compression. There are no screw threads, or other parts subject to deterioration from exposure. The wire pin is more perfect in its details than any similar pins that have heretofore been introduced. The objects aimed at in the design of this insulator are, great strength, high insulation, small size, convenence, durability and cheapness. This insulator is manufactured by Messrs. Emmet Bros. & Griswold, 150 Broadway, New York, who will send samples free to any one wishing to examine it.**



The "Cinch" Trolley Wire Insulator.

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[1] The Electrical Engineer, April 22, 1890.

PAPER INSULATION FOR ELECTRIC LIGHT AND TELEPHONE PURPOSES.

One of the most important strides in the matter of insulation of cables for powerful electric light currents has been made within the last three or four years. Many materials have been tried and found more or less wanting. The mechanical and electrical requirements of a 10,000 volt conductor of the present day are very exacting. The cable must be light and flexible; it must be strong enough to withstand the strain, and wear and tear of reeling and unreeling and hauling through crowded conduits without exposing the insulation to damage. The insulation must be high at normal temperatures, so as not to fall too low when exposed to excessive heat, and it must further be able to retain its power of preventing a breakdown or blow out even when the insulation has fallen very low from such exposure.

The Norwich Insulated Wire Co., of this city, claim that these requirements are met absolutely in their cables, in which paper is employed as the insulator. This company are working night and day to meet the demand for their cables, which is chiefly for No. 6 B & S wire leaded cable, outer diameter ⅝ inch. Some twenty-five miles of this cable is now being laid in New York alone, and in Chicago over thirty miles have been laid, whilst orders have been filled for England, France and Germany, including a very large sectioned 10,000 volt concentric Ferranti cable. The company has yet to receive its first complaint of a break down, although their cables have been laid and jointed by the lighting companies' regular cable men, who use their own way of jointing, the company finding it unnecessary to recommend any special method.

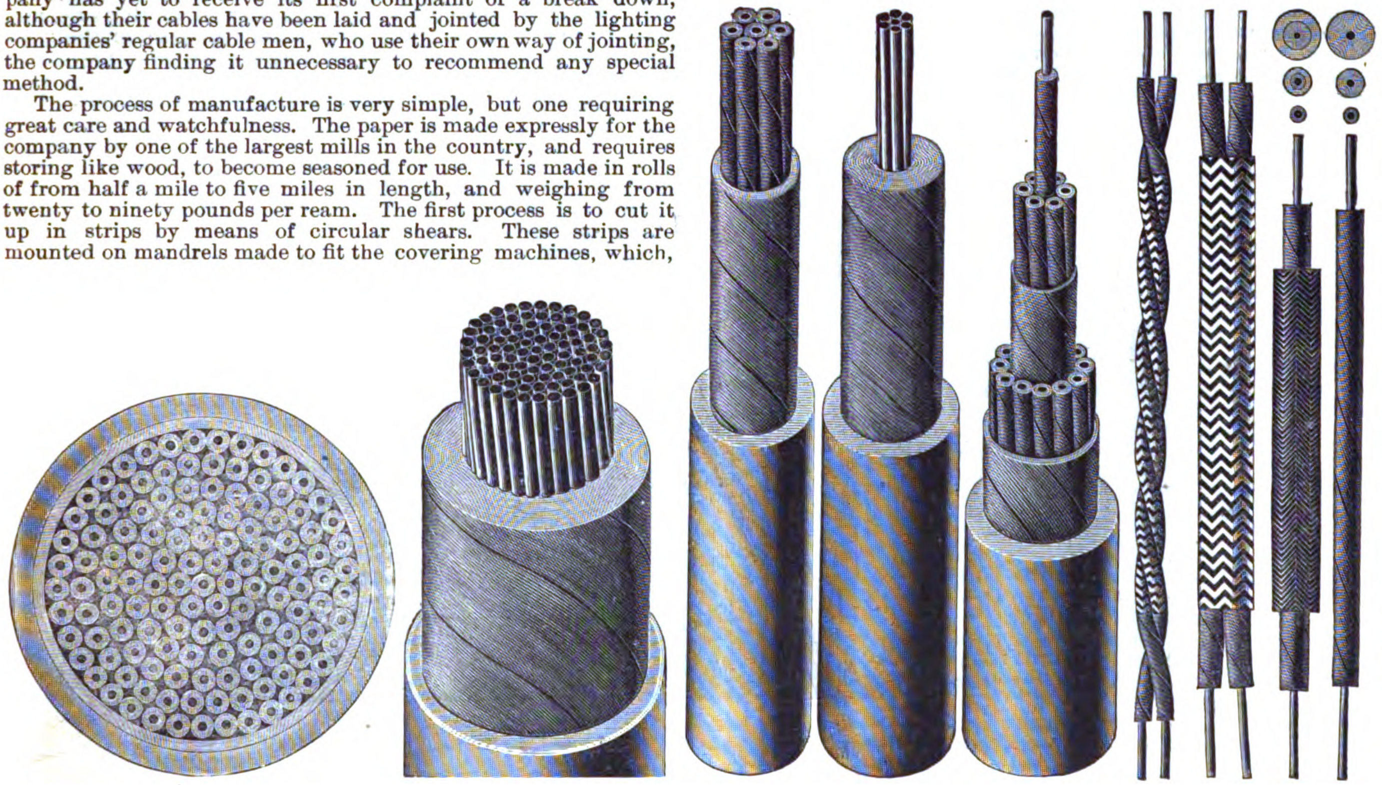
The process of manufacture is very simple, but one requiring great care and watchfulness. The paper is made expressly for the company by one of the largest mills in the country, and requires storing like wood, to become seasoned for use. It is made in rolls of from half a mile to five miles in length, and weighing from twenty to ninety pounds per ream. The first process is to cut it up in strips by means of circular shears. These strips are mounted on mandrels made to fit the covering machines, which, revolving at from 60 to 500 turns per minute, according to the size of the conductor, lay the paper on it in overlapping spirals.

As with every spiral laid on, the cable is passed through closely fitting dies, the result is a very hard, dense, compact and flexible covering, very difficult to damage or abrade and at the same time one of exceedingly uniform diameter. The layers of paper are laid on with their spirals alternately in opposite directions.

After covering to the requisite thickness the cable is wound on open iron reels and placed in drying ovens where it is exposed to a temperature of about 250° F., until all the moisture is thoroughly expelled. Then, while still hot, it is submerged in compound, which is maintained by steam coils at a heat of some 270° to 280° F, for a length of time depending on the thickness of the insulation or other electrical requirements. The nature of this compound is a close secret. It is then passed directly from the tanks through the hydraulic press which puts on the lead covering. The machinery by means of which the lead is laid on the cable in one continuous length, was designed and constructed under the patents of Mr. J. Draper Bishop, the electrical engineer of the company.

The cables are then tested, when necessary, at a potential of 2,500 volts for insulation, as well as for conductivity and capacity.

The insulation is always high, exceeding on an average 2,000 megohms at 75° F.



Telephone Conf. Cable. Power. Power. Arc. Telephone. Leads.

Paper Insulated Electric Light and Telephone Cables and House Wiring Conductors.

Some of the performances of these cables are remarkable. Lengths of 1,000 feet were submitted to one of the largest electric light companies for the purpose of being tested to "break down." They successfully resisted a strain of nearly ten thousand volts and were finally left intact. The cable was then placed *in boiling water* and kept submerged for *forty eight hours*. While still in the tank it resisted a potential of nearly eight thousand volts before failing.

One most important advantage possessed by these cables is, that, no matter how rough a treatment the cable may be submitted to, even to destroying the lead and rupturing the insulation, the conductor will always remain absolutely concentric. The insulation is uniform throughout every inch of its length and cannot by any accident of manufacture or subsequent treatment become thinner on one side than another, or, in other words, eccentric.

The Norwich Insulated Wire Co. has also made a considerable quantity of telephone cables, over 5,000 miles of conductor being laid in New York alone. The capacity of these cables, when made to conference standard specification, has been reduced, during the past year, from 22 microfarad to below .08 microfarad per mile.

The company has lately increased its plant to a capacity of a mile a day of such cable. Its latest undertaking is the manufacture of paper insulated leads for incandescent house and office wiring.

Our illustrations show a variety of the products of this enterprising company, the officers of which are: Louis D. Beck, president; Anthony Dey, vice-president; E. D. McCracken, general manager. The offices are at 58 Cedar street, and the works at corner of Lorimer and Bayard streets, Brooklyn, N. Y.

THE BALL & WOOD CO.

A circular has been issued by the above company, of 15 Cortlandt street, announcing the fact that they are now prepared to build and furnish improved Ball automatic cut-off engines. Mr. T. C. Wood becomes the president of the new company; Mr. F. H. Ball, is vice-president and general manager; Mr. C. R. Vincent, is secretary and treasurer; and Mr. T. G. Smith, Jr., will be entrusted with the interests of the company, with his principal office at Cincinnati. The management point to the numerous contracts they have carried out with eminent success, and ask for support and patronage under their new régime. They are ready to receive and discuss proposals and give estimates on equipments of any size.

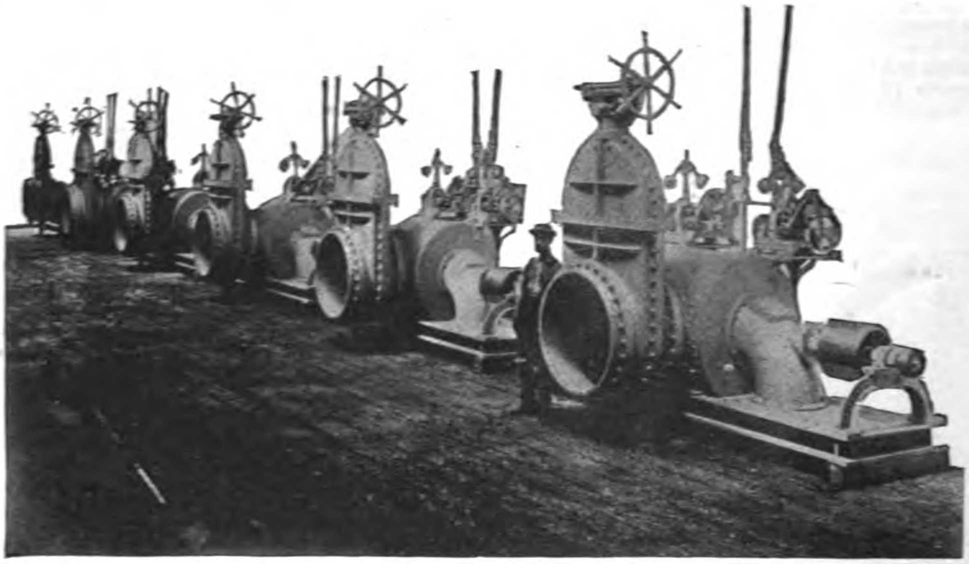
CLEVERLY AS A PATRON OF ART.

After complimenting his friends for a long time past and quite frequently with articles of the "bigotry and virtue" kind, such as calendars, thermometers, preserve dishes, etc., Mr. H. A. Cleverly, of Philadelphia, has hit upon the happy idea of presenting those whom he wishes to bear him closest in mind with a very handsome terra cotta alto relief portrait of himself. This portrait is set in a massive cocoanut frame, the husk of which is so broken as to make a fringe of hair over the cotta brow and a rim of beard around the terra chin. As a general thing, busts and plaques have a stiff, formal "in memoriam" look, but to make this of his as easy and lifelike as possible, Mr. Cleverly has placed a modest dudeen between the smiling lips. Mr. Cleverly may well be content to go down to posterity in this guise. In some of the alto reliefs, in order to make them more racy of the Philadelphia soil, a dainty touch of moss has been added to the frame.

THE STILWELL & BIERCE MFG. CO.

SINCE electrical transmission has so greatly increased the value of water power, the Stilwell & Bierce Mfg. Co., of Dayton, Ohio, manufacturers of the celebrated Victor turbine, are making a leading specialty of designing and installing complete water power plants for electrical purposes and are doing an extensive business.

As an example of some of their recent work, we illustrate in the accompanying engraving a line of 10-inch Victor turbines on horizontal shafts complete with flume, bed-plate, governors, etc., designed and built for the Edison Electric Illuminating Co., of Spokane Falls, Wash., for a special service. These turbines operate under 70 feet head, developing 186 h. p., and are arranged for driving two dynamos direct from the turbine shaft. The feeder is provided with a valve gate for shutting out water. Each turbine is entirely independent, being provided with a separate gate and governor, so that either one, or both, can be operated at will. While this pair of wheels was designed expressly for driving the two dynamos, it will be readily seen that similar designs can be adapted to a great range of work.



VICTOR TURBINES AT THE EDISON ELECTRIC ILLUMINATING CO.'S STATION, SPOKANE FALLS, WASH.

Six pairs of these turbines are supplied with water from one feeder, a branch extending to each pair. The same station has also a pair of 15-inch Victor turbines on horizontal shafts, equipped with disc friction pulleys; an arrangement which is very simple, compact and strong.

The catalogue of the Stilwell & Bierce Mfg. Co., illustrates a great variety of work of this kind, and is of especial interest, as it shows their ability to meet the requirements of peculiar and difficult locations.

UNIVERSAL ARC LAMP CO.

The above company, of 42 Broad street, this city, have appointed Mr. C. C. Sibley, their general manager. Mr. Sibley has sold out the electrical manufacturing business of C. C. Sibley & Co., to the Interior Conduit and Insulation Co., and has entered upon his new duties.

GENNERT'S COLORINE.

A great many central station men require colored incandescent lamps from time to time. An order comes in for special ball or banquet lighting, or perhaps for a wedding or reception. It doesn't seem good economy to have a lot of costly colored incandescents lying around the station, and so very often the chance to make extra earnings in this way is allowed to slip. We speak from actual experience and knowledge. Many managers have endeavored to meet the situation by getting up some artificially colored lamps for themselves—with preparations or dodges of their own. They have not always been successful. The E. P. Gleason Manufacturing Co., of Mercer street, this city, have had this matter forced upon their notice more than once, and have often been called upon to get up colored incandescents in a hurry for their central station friends. Quick as usual to meet a new want, the company have now placed on the market, through the ingenuity of Mr. E. F. Gennert, a preparation to which they have given the name of "Gennert's Colorine." It is made up in half-pint bottles that cost only fifty cents apiece, and can already be had in all the primary colors, of brightest hue. Each bottle will color 100 lamps thoroughly, and they will then stand exposure to weather or heat indefinitely. At the same time, the lamps can soon be made available again for ordinary every day duty, so that at no time need a manager carry a stock of lamps that are not earning something. Simple instructions go with each bottle. We have ourselves inspected some lamps treated in this way, and found them admirable. The preparation does not dim the glass and yet it sticketh closer than a porous plaster, refusing to come off even under the most vigorous application of the finger nail. We think the E. P. Gleason Manufacturing Co., have made another decided hit, and believe that "Colorine" will become as indispensable a part of a station outfit as lamps or engines or oil.

ELECTRIC MERCHANDISE CO.

During the last few months the above company, of 11 Adams street, Chicago, have received a number of orders from tramway companies in foreign countries, and have also received inquiries almost daily regarding the practical working of electric street railways in this country. This has led them to look into the matter carefully, and after correspondence with parties interested, they believe that foreign roads are ready to adopt at once, the electric railway system as used in this country, if the advantages can be fully explained to them. Mr. Frank X. Cicott, of the company, having spent some months last year travelling in Europe, also became convinced of this fact. Believing that it would be to their interest to be early in that field, they have decided to send Mr. Cicott as their representative to foreign countries, and he sailed on the Cunard "S. S. Servia," on Saturday the 9th inst. to spend probably two months in working up an interest in such matters. Such enterprise as this deserves more than passing notice, and will bring its own reward.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. MAY 20, 1891. No. 159.

A VISIT TO THE CROCKER-WHEELER ELECTRIC MOTOR CO.'S FACTORY.

ALTHOUGH one of the newest of the arts, the designing and building of electric motors has now reached a stage of development which places them foremost in the ranks of prime-movers. The laws upon which such machines are designed have been laid down with accuracy sufficient to enable the competent electrical engineer to design a machine which shall, when constructed, vary but a small fraction from the calculations upon which its construction is based. But, as in every machine required for continuous use, and especially so in a prime mover, the mechanical design is a subject of no less important consideration. Among those constructors who have given probably equal attention to both these important qualities in a motor, are Dr. S. S. Wheeler and Prof. F. B. Crocker, and we think that, in view of the contemplated visit of the American Institute of Electrical Engineers, to the factory of the Crocker-Wheeler Motor Co., a description of their latest types of machines now being manufactured, together with the methods employed, will be of interest.

The company are now situated in an enlarged new shop, where the manufacture of their machines is carried on under the direct supervision of Dr. Wheeler, and special pains have been taken to make all parts to standard gauges, so that they may be interchangeable, for which purpose the best metal working tools have been procured. The accompanying illustration, Fig. 1, gives a general view of the machine shop, and Fig. 2 that of the armature winding room. The Crocker-Wheeler motors, throughout the entire range of sizes, are built up of a cast iron base plate, into which drop forged wrought iron magnets are inserted and which encircle an armature consisting of laminated wrought iron.

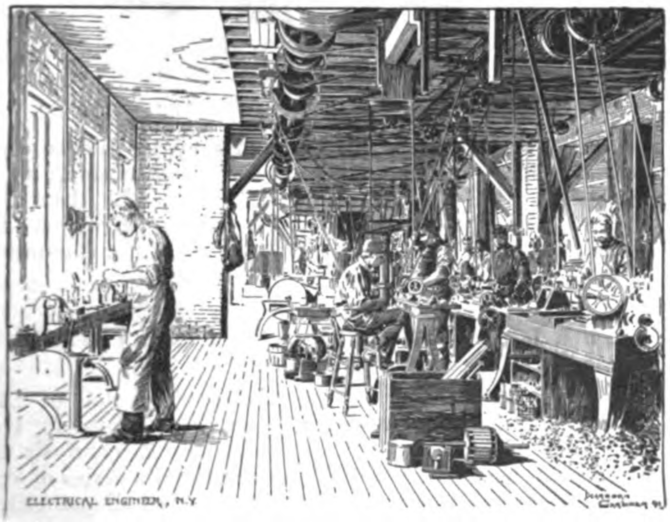


FIG. 1.—MACHINE SHOP; CROCKER-WHEELER MOTOR CO.

The latest form of armature adopted presents several points of interest. As will be seen in the accompanying illustration, Fig. 3, a toothed armature is employed, but the spaces *a*, instead of having their sides parallel, are trapezoidal, which construction, as will be presently shown, has several marked advantages. In the first place the increased surface afforded by the outer edge of the tooth, reduces the reluctance of the magnetic circuit, affording an easier path for the magnetic lines from pole-piece to armature, and vice versa. To this is added the fact that it holds the wire firmly in place and prevents its being thrown out by centrifugal force, while, at the same time, it protects it against mechanical injury. The outside of the teeth, being large, present an almost continuous surface to the pole-pieces, and, as a consequence, the formation of Foucault currents is avoided, notwithstanding the fact that the pole-pieces are solid. Were this not the case the pole-pieces would, as has frequently been demonstrated, require to be laminated.

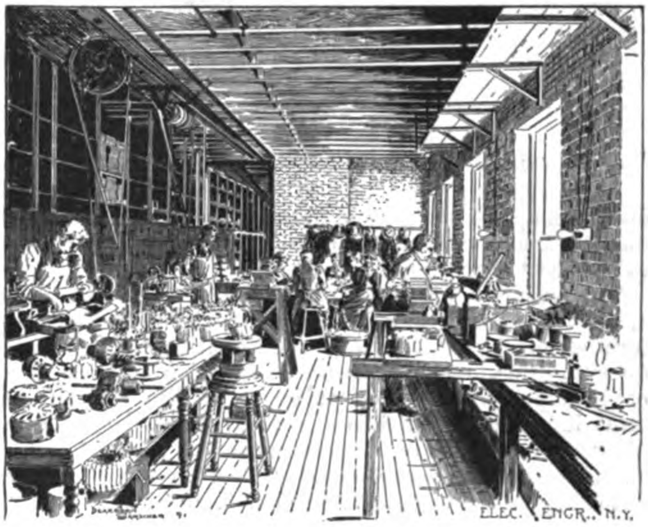

ELEC. ENGR., N.Y.

FIG. 2.—ARMATURE ROOM; CROCKER-WHEELER MOTOR CO.

The trapezoidal form of slot, it will be noticed, corresponds exactly to the natural forms of the sections on the inside of the Gramme ring, thus securing a symmetrical winding and economizing space. It will also be noticed that the pole pieces are brought farther around the armature on the side away from the field coils T T than on the the other side *t t*, by which the tendency to a greater magnetic pole on the side nearer the coils is counteracted. The armature is built up, as will be seen, of two half sections A A, upon which the windings are wound and which are then joined together by means of bolts B B.

Another improved method of construction has been adopted, as a result of which the machine work done on the motors is largely reduced. Heretofore it has been customary to assemble the magnetic skeleton of the machine and to bore out the pole pieces to conform to the space occupied by the armature. The method adopted by the Crocker-Wheeler Company simplifies this construction and obviates the necessity of boring out the field poles. As already stated, the field magnet cores, together with their pole pieces, consist of single drop forgings. Two of these forgings are placed around a dummy armature and the whole is then clamped in a jig, whereupon the base of the machine is bored and the ends of the magnet cores are trimmed to shape so that, when inserted into the base and the dummy armature withdrawn, the magnet cores will occupy exactly the position intended.

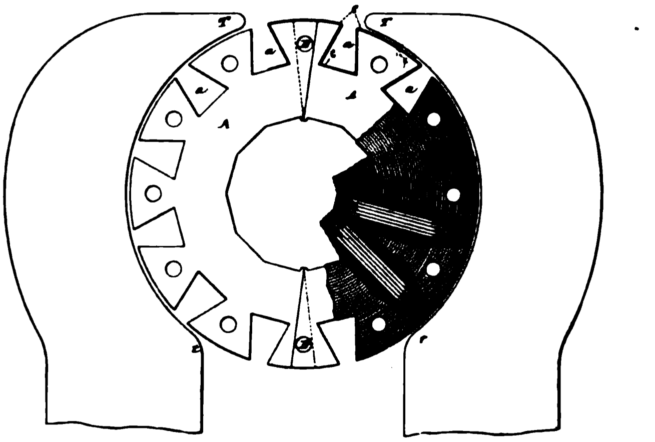


FIG. 3.—NEW CROCKER-WHEELER ARMATURE.

The machines are assembled in the shop shown in Fig. 4, and thoroughly tested in the shop shown in Fig. 5, before being sent out. One of the excellent features introduced on these machines is the designation, on each, of not only the power and speed at which it is to run, but also other information which is of value, not only to the manufacturer, but to the user; thus on the end plate of each armature of the half horse power 500 volt motor we note the following: 24 sections, 177 turns, No. 29 wire.

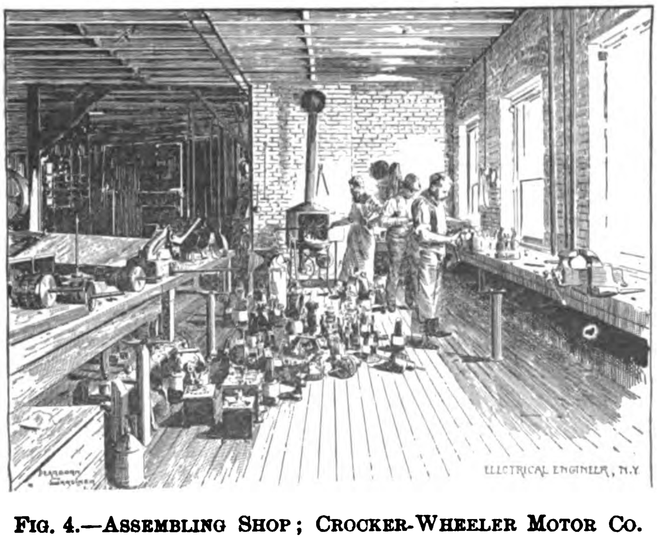


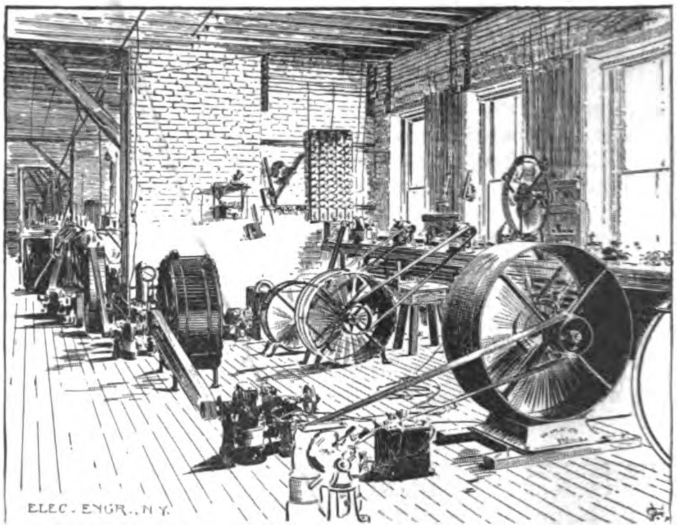
FIG. 4.—ASSEMBLING SHOP; CROCKER-WHEELER MOTOR CO.

The machines, the general type of which is now well-known, are built in 8 sizes, ranging from $\frac{1}{16}$th h. p. to 5 h. p. The smallest machine has a spider which grips both sides of the armature ring and thus gives a firm connection, while on the larger machines, the armature is secured to a face plate by bolts running through the armature teeth. All the machines are built with self-oiling boxes, so that they require no attention for weeks at a time. The trouble frequently experienced with copper brushes has also been obviated by the introduction of a special kind of carbon brush, which, besides making good contact, has very high lubricating qualities and leaves the commutator smooth.

With machines of the larger type are provided regulator boxes, all of which are constructed without wood; slate and iron alone being employed for the tops and sides, and the rheostat coils are designed to carry the full current for prolonged periods without heating. These boxes are so arranged that the throwing of the switch first closes the circuit through the field, energizing the magnets, after which the armature is thrown in circuit so that it at once generates a counter E. M. F. and starts at full power, but without the heavy rush of current.

Besides the constant potential machines of all sizes and for all potentials built by the company, they also manufacture arc motors, a new type of which will shortly be brought out, and the regulation of which is effected in a remarkably simple manner. One of the latest adaptations of the Crocker-Wheeler motor is called the LaRue combination, which consists of a ventilating fan and motor mounted in the same iron frame and affording a very compact installation.

The machines of the Crocker-Wheeler Motor Company throughout their varying sizes have each been separately designed for their stated powers, and may be said to embody the most modern principles of construction, both electrically and mechanically. We may add that the Thomson-Houston Electric Company have arranged to secure from the Crocker-Wheeler Electric Motor Company all motors under 2 h. p. required by them.


ELEC. ENGR., N.Y.
FIG. 5.—TESTING ROOM; CROCKER-WHEELER MOTOR CO.

ELECTROLYSIS APPLIED TO QUALITATIVE ANALYSIS.

At a recent meeting of the Liverpool Section of the Society of Chemical Industry, a paper was read by Dr. Charles A. Kohn, on the "Application of Electrolysis to Qualitative Analysis." Dr. Kohn described a series of experiments he had made on the detection of small quantities of the mineral poisons, antimony, lead, mercury, and copper, taking advantage of the quantitative electrolytic methods of analysis, an account of which he had given to the society on a previous occasion. The methods were very delicate, clean, and decisive, and likely to be of value in cases of medical and of medico-legal inquiry. Very small quantities of silver and of gold could also be detected electrolytically with ease, and the methods had the further advantage of being made approximately quantitative when desirable.

A NEW METHOD OF MEASURING INSULATION RESISTANCE.

BY

Geo. W. Patterson, Jr.

The usual methods of measuring insulation resistance, having failed to give satisfactory results when used in testing a sample of insulated wire, it became necessary to seek for another. The method which was finally used has certain resemblances to two others, namely, the direct deflection and the fall of potential methods, which are well known; but as it avoids the principal fault of each of these methods, at least when applied in this case, it seems original enough to be worth communicating.

The fault of the direct deflection method is that, if the wire has an insulation resistance of, say, over a hundred thousand megohms, it is very difficult, using an electromotive force of less than several hundred volts, to obtain a galvanometer which is at the same time both sensitive enough to give a large deflection, and stable enough to give a constant zero reading. The fault of the second method is, that an insulated wire of even short lengths, if connected with a source of electricity, will go on increasing its charge for several minutes at a considerable rate and sometimes for even an hour at a measurable rate. This increment does not increase the apparent charge; for part of the charge has become, for the time being, latent. It is said to be absorbed. This absorbing goes on even after the source of electricity is removed. A charge, once absorbed, is not readily given up; consequently a wire will appear to have leaked all that has been absorbed between the time its charging ceases and the time it is discharged.

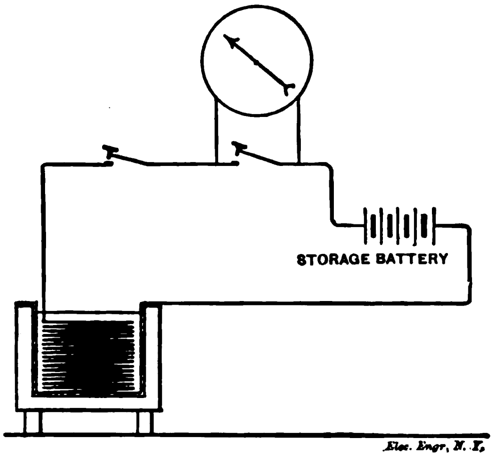


Fig. 1.—A New Method of Measuring Insulation Resistance.

The sample of insulated wire, the subject of the experiment, was one thousand (1,000) feet in length, and No. 18 B. & S. gauge. In the course of the experiment it was found to have an insulation resistance of about ninety thousand (90,000) megohms and a capacity of about eighty-two thousandths (0.082) of a microfarad. In order to insure its being well wet, it had been kept for several months in the tank of water in which it lay during the experiment.

The two methods which were first used and which proved unsatisfactory, were as follows:—In the former, the direct deflection method, the wire and the lining of the tank were connected with the terminals of a storage battery of 62.5 volts E. M. F., through a Thomson astatic galvanometer of 6,656 ohms resistance, and keys which allowed the cutting out or the reversal of the galvanometer, as well as the making or breaking of the main circuit. The galvanometer, which was read by means of a telescope and scale, was about as sensitive as one could make it and still feel confident that the zero would remain unchanged. For convenience the telescope and scale were put at such a distance that each millimetre of the scale corresponded to a thousandth (0.001) of a microampere.[1]

While the wire was charging, the galvanometer was cut out; after a few seconds it was again thrown into circuit, and when the needle came to rest, the steady deflection was read. Reversing the galvanometer gave a deflection in the opposite direction. The mean deflection was taken. As the needle was somewhat unsteady, it was difficult to read the deflection to within a tenth. As nearly as the reading could be made, it was about 0.7 mm. This would indicate a current of about 0.0007 of a microampere, there being, as before, a possible error of one part in seven. The insulation resistance is obtained by dividing E. M. F. by current. In this case it was, within one part in seven, 90,000 (90,000 ± 13,000) megohms.

The uncertainty of the result being so great, the second method was then tried. This was the well-known loss of charge method. It may be briefly described as follows:—First, the capacity of the wire is measured and then it is charged for some definite period and immediately discharged through a ballistic galvanometer. It is then recharged as before, but, instead of being immediately discharged it is insulated for some suitable period, in order that part of the charge may be lost; after the period has elapsed it is discharged through the galvanometer. The ratio of the two readings is the same as the ratio of the E. M. F.'s at the beginning, and at the end of the period of insulation. Dividing the length of the period (in seconds) by the product of the capacity and the Napierian logarithm of the ratio of the potentials, gives the insulation resistance

$$R = \frac{t}{C \cdot \log_e \left(\frac{V_0}{V_t}\right)}. \qquad [1]$$

Several different lengths of the periods of charging and of insulation were taken. Calculating the insulation-resistance by equation [1], various results were obtained. They were, on the average, not greatly different from the result previously obtained; but as they differed among themselves, by fully fifteen thousand megohms, it was evident that this method was, in this case, no more satisfactory than the previous one. These variations in the result are doubtless due to absorption.

Neither determination being considered sufficiently accurate, it occurred to me that the first method might be so varied as to avoid the small readings and still use no greater E. M. F. The variation consisted in charging the wire and, having insulated it, to allow the leakage to go on unreplaced for a suitable period of time and then to measure the quantity of electricity which was needed to charge the coil as before; for, although the deflection of the galvanometer was too small to be accurately read, if the leakage from the wire was continuously replaced, yet when the leakage for a period of even a few seconds was replaced in an instant, the throw of the needle became considerable. In order to simplify the calculation, a ballistic galvanometer was set at such a distance from the telescope and scale that each mm. of deflection corresponded to one-thousandth (0.001) of a microcoulomb. The constant of any ballistic galvanometer is obtained by dividing the quantity of electricity producing the throw of the needle, by the number of scale divisions of the deflection. The quantity of electricity is measured by the product of the capacity of the condenser and the E. M. F. of the cell used. In this case we used a Carhart-Clark standard cell of 1.440 volt E. M. F. to charge an Elliott condenser of one-tenth (0.1) of a microfarad capacity. The condenser was then discharged through the galvanometer, giving a reading of

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[1] One million microamperes equal one ampere.

144 mm. Or, expressing the constant in the form of an equation,

$$K = \frac{V_{s.c} \, . \, C_1}{D_1}, \qquad [2]$$

where $V_{s.c}$ = the E. M. F. of the standard cell; C_1 = the capacity of the condenser; and D_1 = the reading of the galvanometer.

K is also equal to $\frac{Q_2}{D_2}$, where Q_2 and D_2 are any quantity of electricity and the corresponding deflection, respectively. Therefore

$$Q_2 = \frac{D_2}{D_1} \, . \, V_{s.c} \, . \, C_1. \qquad [3]$$

The wire was then connected with the storage battery as first described [Fig. 1], and to insure its becoming fully charged, was left on closed circuit for half an hour. Next the galvanometer was introduced into the circuit, and at some carefully noted time, the circuit was broken. After a certain period, say, thirty seconds, the key was closed for an instant and the throw of the galvanometer was noted. After another like period a second reading was taken, and so on for a considerable time. It may be remarked here that the fall of potential is so slight in short periods, that the deflections are, within the limits of errors of observation, proportional to the length of the periods; consequently, even if there should be large variations in the lengths of the separate periods, the summation of the readings for, say, five minutes will remain practically a constant. This constant for five minutes was found to be within two of two hundred and ten (210 ± 2), which would make the value for a period of thirty seconds within two-tenths of twenty-one (21 ± 0.2).

It was noticed that if the readings were begun before the charge had become practically a maximum, that the readings were somewhat larger, but became rapidly less, and in the course of half an hour had almost reached their minimum. If considerably longer periods were chosen, it was noticed that there was a perceptible falling off even after an hour; but for the shorter periods of thirty seconds this falling off was not noticeable after half an hour.

The usual formula for rate of loss of charge is

$$\left(\frac{d\,Q}{d\,t}\right) = \frac{V}{R}, \qquad [4]$$

where $\left(\frac{d\,Q}{d\,t}\right)$ is the first derivation of the charge with respect to the time, and V and R are the E. M. F. and the insulation resistance respectively. If, during a time t, the change in the value of V, $[V_o - V_t]$, is so slight as to be negligible, then

$$\frac{V_o}{R} \pm \frac{Q_o - Q_t}{t}, \qquad [5]$$

when the subscripts o and t denote, respectively, immediately after charging and after a further time t.

If D_2 is the deflection produced by the quantity $(Q_o - Q_t)$, then

$$Q_o - Q_t = D_2 \, . \, K; \qquad [6]$$

consequently, by equations [2], [5] and [6],

$$R = \frac{D_1 \, . \, V_o \, . \, t}{D_2 \, . \, V_{s.c} \, . \, C_1}. \qquad [7].$$

Taking the average reading for thirty seconds to be within two-tenths of twenty-one [21 ± 0.2] mm., we have in this case

$$R = \frac{144 \times 62.5 \times 30}{(21 \pm 0.2) \times 1.440 \times 0.1} = [89{,}200 \pm 800] \text{ megohms.}$$

Should V vary during the time t, so as to cause error in the result, an average value may be taken. For all practical purposes we may take the mean of the highest and the lowest values $\left[\frac{V_o + V_t}{2}\right]$; but if an absolutely exact value is needed it is:—

Average value of V =

$$\frac{V_o}{1 + \frac{1}{2}\left(\frac{Q_o - Q_t}{V_o\,C}\right) + \frac{1}{3}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^2 + \frac{1}{4}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^3, \text{ etc.}}$$

This may be shown as follows:—

It is evident that $V_t = V_o - \frac{Q_o - Q_t}{C}$; dividing by V_o we have $\frac{V_t}{V_o} = 1 - \frac{Q_o - Q_t}{V_o\,C}$. By equation [1]

$$R = \frac{t}{C \, . \, log_e\left(\frac{V_o}{V_t}\right)} = \frac{t}{C\left[-\,log_e\left(\frac{V_t}{V_o}\right)\right]} = \frac{t}{C\left[-\,log_e\left(1 - \frac{Q_o - Q_t}{V_o\,C}\right)\right]}$$

Expanding the logarithms into a series gives

$$-\,log_e\left(1 - \frac{Q_o - Q_t}{V_o\,C}\right) = \frac{Q_o - Q_t}{V_o\,C} + \frac{1}{2}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^2 + \ldots + \frac{1}{n}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^n + \text{ etc.}$$

Substituting and simplifying

$$R = \left[\frac{t}{Q_o - Q_t} \times \frac{V_o}{1 + \frac{1}{2}\left(\frac{Q_o - Q_t}{V_o\,C}\right) + \frac{1}{3}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^2 + \ldots + \frac{1}{n}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^{n-1} \text{ etc.}}\right]$$

Therefore by equations [2] and [6],

$$R = \left[\frac{D_1 \, . \, t \, . \, V_o}{D_2 \, . \, C_1 \, . \, V_{s.c}} \times \frac{1}{1 + \frac{1}{2}\left(\frac{Q_o - Q_t}{V_o\,C}\right) + \ldots + \frac{1}{n}\left(\frac{Q_o - Q_t}{V_o\,C}\right)^{n-1} + \ldots}\right] \qquad [8]$$

If the first two terms of the series are taken, the rest being neglected, it may be easily shown that the result is the same as if the mean between the highest and the lowest values of the E. M. F. had been taken and substituted for V_o in equation [7].

In the case of the wire on which these experiments were made, even the second term may be neglected, with an error of less than one third of the possible error due to irregularities in the readings, for

$$\frac{1}{2}\left(\frac{Q_o - Q_t}{V_o\,C}\right) = \frac{21 \times 0.001}{2 \times 62.5 \times 0.082} = 0.002048.$$

The next term of the series will be 0.000,006. Applying the whole correction R = [89,000 ± 800] megohms.

This method has also been used in testing another sample of a thousand feet of insulated wire, which after being in the water one day had an insulation resistance of about five hundred thousand (500,000) megohms. (The insulation-resistance has since fallen to about one-fifth of that amount. A final determination has not yet been made.) The first method applied to this was a total failure. There was no readable deflection of the galvanometer. On applying my method the deflections were quite large at first and decreased for several hours. After four hours they had fallen to about one third of the value, which they had twenty minutes after the charging began. There was evidently considerable absorption.

In presenting this method, I would call attention to what I consider its chief advantages over the more common methods. In the first place, supposing that the wire has sufficient capacity to admit of the use of the method, we may apply it in any case when the first method (the direct deflection) would fail. The higher the insulation resistance becomes, the more easily is this method applied, for it requires simply that the observations be taken at greater time intervals. Absorption of the charge causes no inconvenience beyond making it necessary that the wire be left charging during a longer time. In the second place it is far more accurate than either of the other methods; and, when there is added to these the extreme simplicity of the calculations, which are made without recourse to Napierian logarithms, it would seem as though the worth of the method were established.

Laboratory of Physics,
University of Michigan.

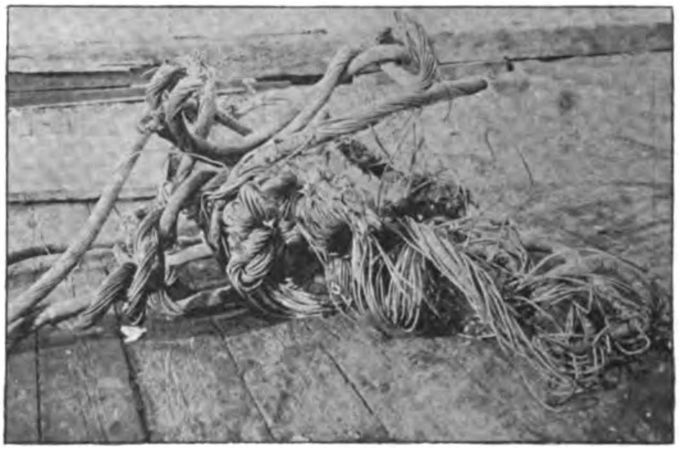
SUBMARINE CABLES IN SHALLOW WATERS—WHAT THEY HAVE TO PUT UP WITH.

BY

Herbert Laws Webb

SUBMARINE cables laid in shallow waters are often exposed to greater risks and rougher treatment than the great ocean cables which sometimes cost their owners a small fortune in repairs. Not long ago an ocean going steamship, in leaving her dock at Jersey City, ploughed up the soft bottom with her powerful propeller, and secured a costly and valuable catch in the shape of about a dozen submarine cables, which enmeshed themselves in the blades of the propeller so effectively that all the cables were torn asunder and the ship had to go into dry dock to clear her screw of the garlands of iron, hemp, and Kerite, with which it had become embellished—not to say embarrassed. The learned judge who presided over the argument as to whether the telegraph company, which owned the cables, or the steamship company, which owned the inquisitive vessel, was the aggrieved party, decided in favor of the latter, holding that a harbor is to be kept free for navigation, and that a steamer is entitled to plough through mud as well as water, cables or no cables. If the cables were thought to be secure because they were lodged in two feet of silt, why so much the worse for the cables, or rather for their owners. According to the learned judge, ocean steamers possess the right of way through the silt, even down to hard rock, and the waters of a harbor for purposes of navigation have no "bottom." This is cold comfort for owners of submarine cables in harbors, but by way of adding insult to injury the very practical suggestion was made that cables might be laid in a species of submarine trench, and thus be kept out of harm's way when ocean steamers (or others) find it necessary to "take the ground."

It is quite conceivable that the powerful machinery of an ocean steamer should make light work of gathering up, and rending into fragments, a dozen or so of submarine cables, but that a river tug should take to the same game and twist some hundred feet or so of heavily armored 7-conductor cable into a bunch of Gordian knots is a little too much. The accompanying illustration shows how effectively the tug did the work. The cable is the property of the American Telephone and Telegraph Company, and serves to connect the pole line across Staten Island with that running through New Jersey, the cable crossing the Kills between Linoleumville and Carteret. The tug caught up the cable in the most approved manner, according to the laws of harbor navigation, snatched it from its quiet resting place in the silt, and a stern battle between the pugnacious propeller and the inoffensive and defenceless, (though armored), cable ensued. Needless to say the propeller was victorious. The illustration, made from a photograph of the cable lying on the dock in New York, shows that beyond a doubt. The iron armor resisted vigorously, that also is plain; but it was never intended to withstand the attack of a river tug's propeller, so after a stout resistance, accompanied by endless writhings and contortions, it succumbed. The sea serpent itself could not have made a better fight. If the cable was vanquished, its enemy was also at least for a time placed *hors de combat*, for so closely were propeller and cable interlocked in their deadly feud, that the tug had to be brought to New York and put in dry dock in order to separate them. The snarl contains about one hundred feet of cable, and bears strong evidence as to good construction. Few would believe that a cable could resist long enough to be twisted up into such hideous shapes instead of breaking almost at once. The cable, which is a seven conductor, Kerite make, has been down for about five years and was found to be in perfect condition when repairs were made. Indeed the snarl testifies to that.



A SUBMARINE CABLE SNARL.

Not long ago Frank Stockton contributed to one of the magazines a nonsensical story, in which a startling incident was narrated. By a stroke of lightning a steamer had been converted into an immense magnet and had attracted to itself a submarine cable, which held it fast until the cable-ship came to the rescue. This flight of fancy is not altogether without excuse. There is a story of an ocean steamship catching up a piece of cable in the North river and towing it all the way from New York to Liverpool and back without discovering to what mysterious cause the strange reduction of speed on the round trip could be attributed. There is yet another story of a Sound boat which fouled a submarine cable in New York waters and towed a goodly length of it to New Haven. There the piece of cable was cleared away, coiled down on the dock, and subsequently sold by the steamboat company to another corporation whose business it is to maintain electrical communication between places near together and far apart. That corporation put the cable into service, and (so the story goes), is using it at the present time.

DUNKIRK, N. Y.—Judge Lambert has granted an injunction restraining the Board of Water Commissioners of Dunkirk, from buying machinery or materials for the construction of an incandescent light plant, and from raising by tax or otherwise money for creating or operating an incandescent light plant. The suit was brought in the name of A. J. Avery.

NEW STATION OF THE CLINTON GAS LIGHT COMPANY, CLINTON, MASS.

BY

A. C. Shaw.

As an example of another type of New England station of modern construction, I have selected that of the Clinton Gas Light Company, at Clinton, Mass., which possesses one most interesting feature, namely, that it was designed and built entirely to utilize the Evans friction system of driving. This is much more important than at first appears, as such a station, calculated for a certain amount of horse power and lamp capacity, would be absolutely inadequate in regard to space, were any other system of driving adopted.

About 5 years ago, the Schuyler Company of Middletown, erected a station of wood, and installed two arc machines, run by a Fitchburg high speed engine, which station was bought out by the Clinton Gas Light Company. About one year ago the Thomson-Houston alternating incandescent system was introduced, and as business continued to increase, it was determined to build a new station, and eventually land was bought adjacent to the railroad tracks, and in a convenient position for obtaining condensing water. The furnishing of plans and specifications for the complete construction of the station, and the necessary outside construction, was at once put into the hands of the Wright Electrical Engineering Company, of Boston, who afterwards took charge of the whole construction. It was early decided to adopt the Evans system of driving, and plans were drawn up to build the station to accommodate that system. As will be seen by an inspection of the ground plan, Fig. 1, the entire building is 135 ft. 6 in. long by 66 feet wide, and is one story high. The boiler room is 48 ft. 10 in. square, internal measurement, and has accomodation for five boilers. At present there are installed two Robinson boilers, built by the Robinson Boiler Works, of East Boston, Mass., who also furnished the iron smoke stack. The boilers are each of 125 horse power capacity, and work at a pressure of 90 lbs. per square inch. The roof is of wood 24 feet from the floor, and is supported by iron rod trusses.

The engine room is 45 feet 4 inches long by 47 feet 4 inches wide, and has accomodation for two 500 horse power double engines. At present there is installed one half of one of these engines, 250 horse power, of the Fitchburgh compound condensing type, built by the Fitchburg Steam Engine Company, of Fitchburg, Mass. The cylinder is 20 in. in diameter by 40 in. stroke, and the pulley fly wheel is 20 ft. 1½ in. in diameter by 43 in. face, weighing 30,000 pounds, and making 90 revolutions per minute, with automatic governor contained therein. The engine is belted to the shafting by a 42 in. belt, manufactured by Josiah Gates & Sons, of Lowell, Mass., having a drive of 40 feet. In addition to the large engine there is a small high speed Fitchburg engine of 75 horse power to be used when running night and also on day loads. The shafting and dynamo room, Figs. 2 and 4, is 38 feet long by 64 feet wide, and is calculated to contain two lines of shafting, though only one line is at present in place, the one shown in dotted lines being for increase. The shafting is of iron, $4\frac{1}{16}$ in. in diameter, and carries a 6 foot main driving pulley on quill shaft, three 75 in. pulleys with 15 in. face for driving the alternating machines, one 54 in. pulley with 10 in. face for the arc machines, and a 40 in. pulley with a 4 in. face for driving the exciters. Two Hill clutches are used for throwing in either engine. The engine and dynamo room roof is of wood with a strong iron truss, and has a slight pitch, and is covered with five-ply tar and gravel.

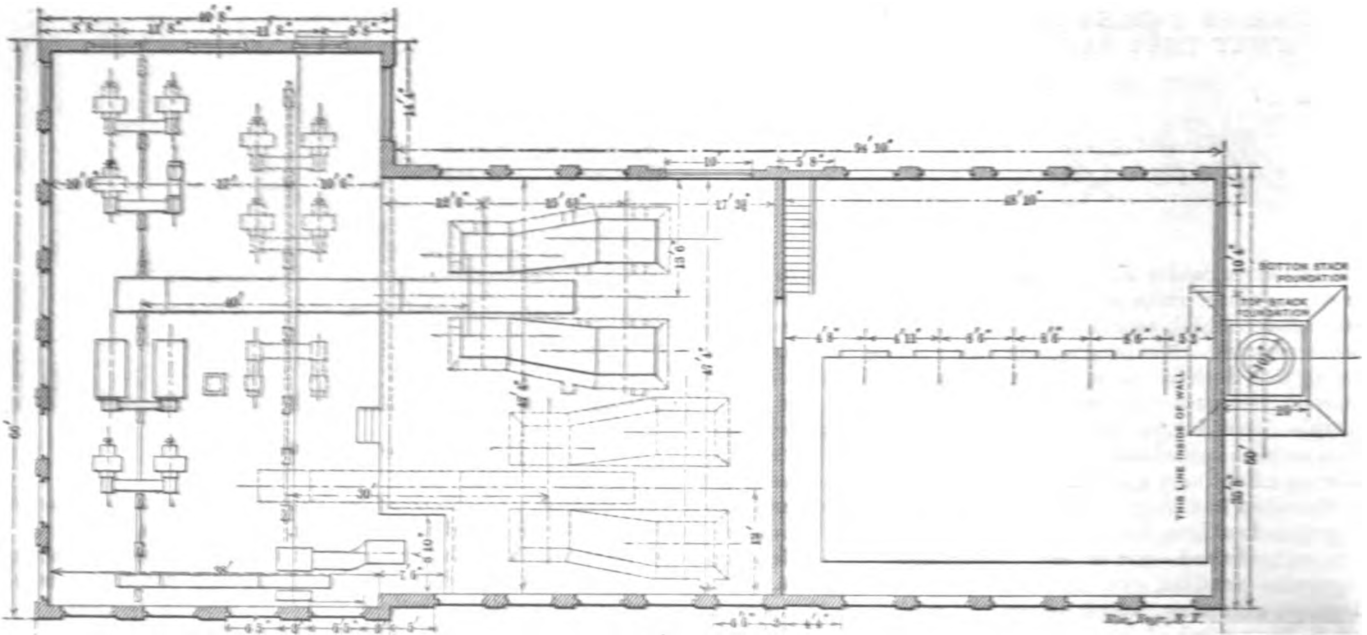


FIG. 1.—ELECTRIC LIGHT STATION AT CLINTON, MASS.—PLAN.
Plans and Specifications Furnished by the Wright Electrical Engineering Co., of Boston.

The foundations are built up of solid stone and brick, with granite cap stone. In the cellar is a Wainright heater, a Deane condenser, and feed water pump, and Korting injector. The engine flooring rests on brick piers, with 8x8 in. spruce stringers, and 3 in. spruce flooring with ⅞ in. maple flooring on top. The dynamo room floor is supported on brick piers, with 10½x14 in. Georgia pine stringers, 4x12 in. floor joists, and 3 in. floor plank with ⅞ in. maple on top for finish. The chimney stack is of iron, 90 feet high, 60 inches in diameter, and is calculated for 1,000 horse power. It rests on granite foundations 8 feet deep, the anchor bolts going to the bottom of the foundations, and is built to stand without guys and withstand any wind pressure.

At present there are in service two Schuyler 45 light, 1,200 candle power arc dynamos, two 650 light Thomson-Houston alternating dynamos, two exciters each capable of exciting both alternating machines, and a 30 horse-power Thomson-Houston motor generator.

The wiring from the dynamos to the switchboard is all underneath the floor, and is strung on porcelain knobs, Okonite wire furnished by the Pettingell-Andrews Company, of Boston, being used throughout. One of the special features of the station is the switch-board, a view of which is given in Fig. 3, and which was designed and built by the Wright Electrical Engineering Company. It is composed entirely of iron and slate, and all the necessary instruments for controlling the dynamos are mounted most conveniently upon it. The switches are so arranged both for the arc and alternating machines that any machine can be thrown upon any circuit, or one machine can be thrown upon all the circuits. The exciter switches are so arranged that each alternating machine is ordinarily run from its own exciter, but, in case of failure of one exciter, by throwing the switch both alternating machines can be run from either exciter. The workmanship on the switchboard is excellent, and the arrangement of the necessary resistance boxes, ammeters, voltmeters, switches, etc., is unique. The whole board being composed of iron and slate is, of course, absolutely fire proof. A few feet away is a special small switch-board for the Bernstein series incandescent system, of which there are two circuits of 44 lamps each of 25 candle-power. These lamps are run from the alternating machines, the system being known as the Thomson-Houston street incandescent.

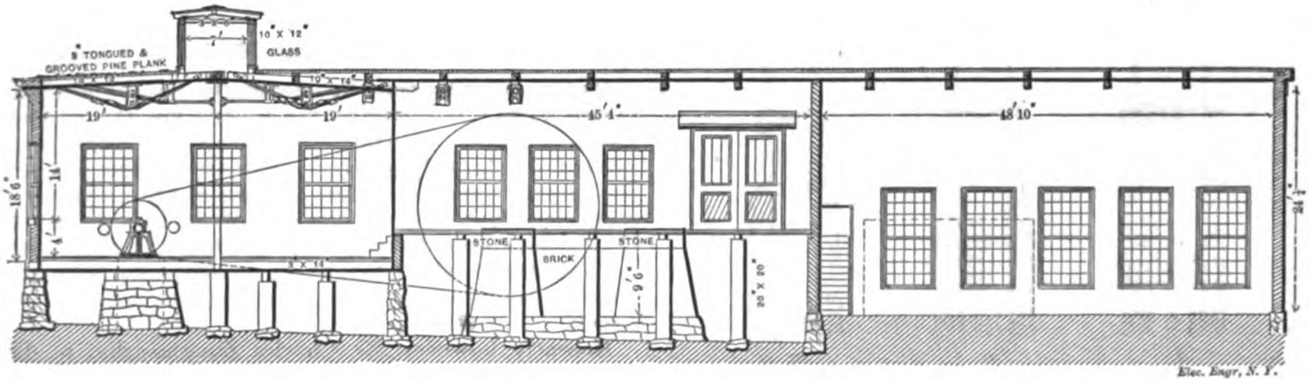


FIG. 2.—ELECTRIC LIGHT STATION AT CLINTON, MASS.—SECTIONAL ELEVATION.
Plans and Specifications Furnished by the Wright Electrical Engineering Co., of Boston.

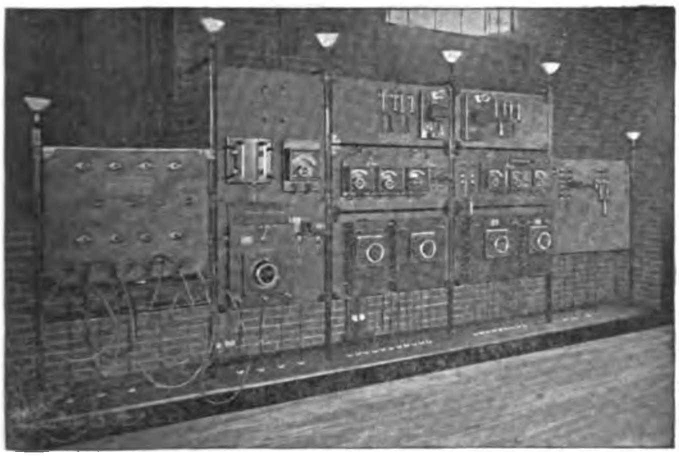


FIG. 3.—SWITCHBOARD—ELECTRIC LIGHT STATION AT CLINTON, MASS.

Directly over the main switchboard is the wire tower, which is reached by a permanent ladder, and in which are contained the lightning arresters, the wire from the switchboard to the outside connections being all Okonite.

About 600 poles have been erected on the outside construction work, and about 35 miles of wire furnished by the American Circular Loom Company of Boston. There are at present in service in Clinton 50 arc lamps, 135 series incandescent 25 candle-power lamps for street service and 650 16 candle-power incandescent lamps for store, factory, and house service, one factory alone using about 200 lamps.

The present officers of the company are: Mr. Eli Forbes, president; Mr. Henry N. Bigelow, treasurer and general manager, and Mr. Wm. H. Spaulding, superintendent, to whom with Mr. Charles H. Herrick of the Wright Company, my thanks are due for the foregoing particulars. The following gentlemen are the directors of the company: Messrs. Eli Forbes, John E. Thayer, Herbert Parker, John R. Foster, Henry W. Bigelow. The plant is a model one all through, and the whole work, both inside and outside reflects great credit on the Wright Engineering Company, who furnished not only the plans and specifications, but superintended the construction throughout. Much of the success of the station is without doubt due to the energy and intelligent management of Mr. Bigelow and Mr. Spaulding.

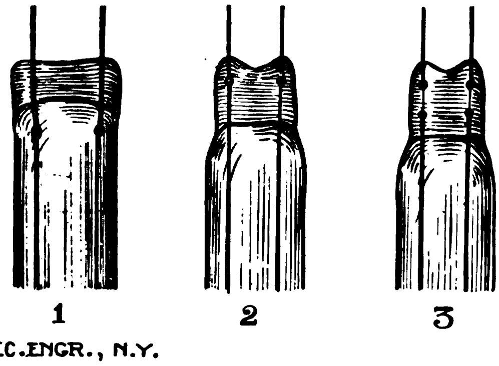
THE WADDELL SIGNAL SYSTEM.

This system, which is now being exhibited at No. 86 World Building, this city, is intended to prevent railroad accidents in tunnels and elsewhere. For this purpose each locomotive carries a battery or small magneto, driven by an engine, and a bell. Between the rails are laid a pair of conductors which are divided into sections, and upon which bear contact wheels or brushes connected with the battery and bell on each locomotive. With only one locomotive on a section the circuit to the bell is broken, but the instant a second locomotive enters upon a section the conductor circuit between the tracks is closed and the bell in the cab sounds an alarm. Should a third or fouth train enter upon a section, upon which two trains were already signaling, they would also receive the signals independent of their position. The arrangement is such, also, that an accident to either the receiving or generating apparatus on any engine would not interfere with the reception of signals by other engines upon its approach. By means of proper connections, bells placed at crossings can be arranged to ring when a train arrives within a given distance and gates could be automatically operated in the same way.

The system is now being exploited by Mr. Maurice Maas and is illustrated by working models at the place mentioned above.

REDUCTION OF PLATINUM IN THE EDISON INCANDESCENT LAMP.

The increasing scarcity of platinum, with its corresponding increase in price, has forced lamp manufacturers to exercise the greatest economy in the use of this valuable metal, while on the other hand, not a few attempts have been made to find a substitute for it. The great value of platinum as a seal, in connection with glass, is due to the fact that it has practically the same coefficient of expansion as glass itself; and again, its nature is such that glass adheres to it firmly. In order to show in what manner the reduction in the amount of platinum required in lamps has been carried out, we give in the accompanying illustrations three views of the successive steps in this direction which the Edison lamp has undergone since its early manufacture. Thus, in Fig. 1, is shown a stem in which two pieces of platinum are employed, the ends of which extend some distance both inside and outside the sealed portion. On account of the low conductivity of, and the heat produced in, the platinum wire, the latter was required to be comparatively large.



Figs. 1, 2 and 3.—Platinum Lamp Terminals.

To reduce this as much as possible, the method shown in Fig. 2 was next extensively employed. This consisted in first soldering a platinum wire of smaller cross section to a copper wire and sealing in such a manner that the platinum wires extended but a short distance into the seal. By this method considerable platinum was saved over the original form adopted.

The latest method, however, has brought down the amount of platinum required to a far smaller quantity than even the one described, and the manner in which this has been accomplished will be readily seen in Fig. 3. Here, it will be noticed, a short piece of platinum wire is joined to two copper wires, one of which passes into the lamp bulb and the other out to the socket terminal. The glass is sealed around this platinum wire and for a short distance beyond, covering a small portion of the copper wire. This forms a perfect seal, and, at the same time, reduces not only the length of platinum wire required to an 1-8 of an inch, but, in consequence thereof, also allows of considerable reduction in its cross section.

A SUGGESTION IN ARC LIGHTING.[1]

BY PROF. C. HANFORD HENDERSON.

The speaker called attention to the fact that progress in illumination has consisted in the substitution of continuous for reservoir systems. In arc lighting the supply of energy is continuous, but the light-yielding substance, carbon, must be frequently replenished. The question as to whether arc lighting could be made continuous had therefore presented itself, and an experimental test was made to use gas issuing from hollow wrought-iron terminals, in place of the solid carbon. It was found that the gas and the arc formed two mutually repellent crescents of light; the terminals were fused and one of the gas jets was closed up. This negative result not being thought conclusive, the suggestion was brought before the Section in the hope of discussing the question as to whether the problem was sufficiently promising to merit further attention.

Prof. Houston stated in discussion that hollow carbon electrodes had been used at different times since 1852, fed by hydrocarbon oil, and by gas containing pulverized carbon, and the like, but without success, owing to the fusion of the terminals. As the intensity of the light varies with the sixth power of the temperature, he considered a continuous arc impossible with our present refractory materials.

ZIPERNOWSKY'S ELECTRIC HEATER.

Heretofore heating by electricity has been obtained in two ways; the first by the electric arc, the second by means of a body introduced into an electric circuit, which presents a relatively greater resistance to the passage of the current transmitted than the rest of the circuit within which it is included. In the case of the electric arc there is total separation between the electrodes. In the second method there is absolute contact or continuity between the body presenting high resistance and the balance of the circuit.

Recently, however, Mr. Charles Zipernowsky, of Buda-Pesth, Austria, has devised a method which may be said to stand midway between the two mentioned, and which consists in the employment of an imperfect contact, its degree regulating the intensity of the heat.

The accompanying illustrations, Figs. 1 and 2, show a view of the apparatus in perspective and in vertical section.

As will be seen, the metal tube A is provided with perforations and a solid soldering point B. The soldering portion and handle are connected to one of the leading-in wires by means of a connector H. Within the tube A is another tube I, having a contact J attached to its outer end, and near to the soldering point. Near the right hand end of this tube is a collar K, over which, and around the tube is placed a helical spring L, bearing at one end upon the collar, and at the other upon the insulating cap M secured to the tube A. By rotating this cap the degree of contact between the point J and the soldering end B may be regulated.

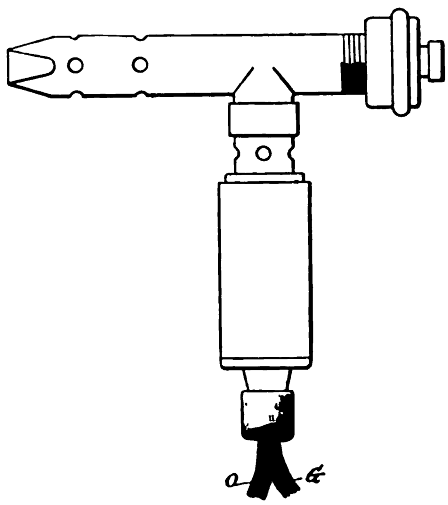


Fig. 1.—The Zipernowsky Electric Heater.

As previously stated, the heat obtained is due entirely to the resistance of the imperfect contact. It will readily be understood that where the tubes of conducting material and the point J are forced into contact with the part B no heat will result when the quantity of current transmitted is within the conducting capacity of the point; and, further, that if the point be brought into imperfect contact without increasing the quantity of current transmitted, considerable heat will be evolved, its intensity depending upon the resistance at the contact points.

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[1] Abstract of a communication to the Electrical Section of the Franklin Institute.

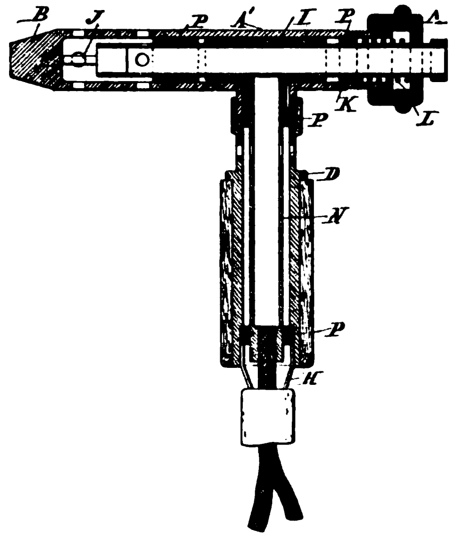

FIG. 2.—THE ZIPERNOWSKY ELECTRIC HEATER.

The perforations are simply for the purpose of keeping the tubes cool, by allowing the heated air within to escape.

NALDER'S HIGH RESISTANCE GALVANOMETER.

THE galvanometer illustrated in the accompanying engravings is designed so as to have the maximum insulation, in order that it may be wound to the highest possible resistance. The instrument, in fact, is wound to as high a resistance as 350,000 ohms with copper, requiring about 18 miles of wire. The coil boxes, which are hinged, are kept closed in position by means of a spring button, thus rendering the use of a screw-driver unnecessary; to open these the button has only to be turned. The suspension is raised by means of a nut; this action does not in any way twist the fibre, the torsion in which is removed by means of the lower milled head which turns independently of the threaded pin. The whole system of the suspension can be removed bodily by loosening the milled side nuts. In order to avert as far as possible, the action of light upon the ebonite, the glass, front and back, windows of the case are provided with black silk blinds.

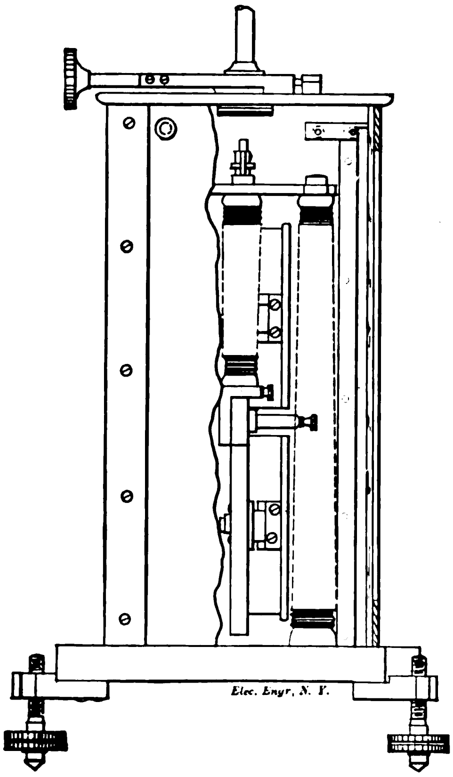

FIG. 2.—NALDER'S HIGH RESISTANCE REFLECTING GALVANOMETER.

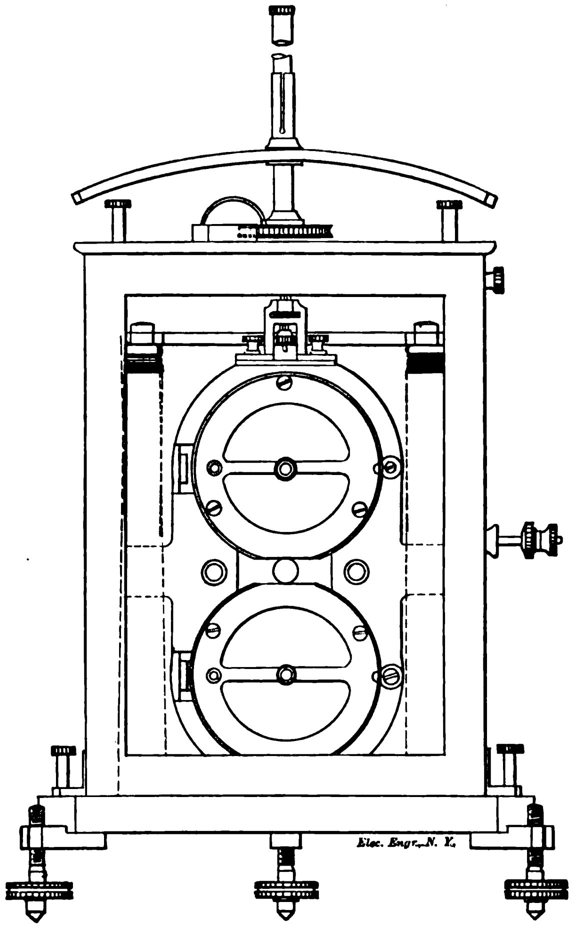

FIG. 1.—NALDER'S HIGH RESISTANCE REFLECTING GALVANOMETER.

This instrument was first made for the Central Institution of the City and Guilds of London. Mr. Mather ofthat institution designed the plan of the pillar supports, and the coils. The instrument is made by Nalder Bros. & Co., of Clerkenwell, London.

MR. MAVER'S NEW BOOK ON TELEGRAPHY.

Mr. William Maver, Jr.'s new book on American Telegraphy, upon which he has spent several years in preparing the subject matter, is now passing through the press. The book will comprise about 600 pages, including over 400 diagrams and engravings. In this work the systems of telegraphy now in use in America, their apparatus, method of operation and the electrical laws involved therein are exhaustively treated; clearly, exactly, and fully described by the aid of very complete and original diagrams, and everything brought up to the present time, 1891.

It is believed that this work will contain more complete information than has ever before been published; in fact the details of many of the systems herein fully explained and thoroughly illustrated, have never before appeared in print.

The book is being published by Messrs. J. H. Bunnell & Co., 76 Cortlandt St., New York, who hope soon to announce its readiness for sale at a moderate price. The well-known ability of Mr. Maver, and his long experience in the telegraphic field, ensure a very large sale for this work.

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> *Theories are means, not ends: but they are the appointed means by which man may raise himself above the low level of merely sensuous knowledge, to heights where his intellectual eye ranges over the boundless prospect which it is the special privilege of the student to behold.*—*Josiah Parsons Cooke.*

ELECTRIC VERSUS STEAM ROADS.

THE beneficial results accomplished in St. Paul by the adoption of electric traction were commented upon in these columns two weeks ago. Our text was an editorial article from the St. Paul *Pioneer-Press*, which said that the introduction of electricity had been worth ten real estate booms to the city. We now have before us another remarkable expression of sentiment, from the sister city of Minneapolis. The *Tribune* of that city announces that the steam roads between the two places have made up their minds to withdraw from competition with the electric line, which, though still so recent, has cut into their business to such an extent that nothing is left of it. These steam roads have been in possession of the field for 20 years, and have been of much benefit to the two communities. Their fares, however, have been 30 cents for the single trip of 10 miles and 50 cents for the 20-mile round trip. When the Lowry electric interurban line went into operation last Fall its fare was put on a 10 cent basis, or 20 cents for the round trip. Besides this, transfers are given at each end of the line to the connecting street car lines, so that the fare comes down in the vast majority of cases to 7½ cents for single trip, or 15 cents for the round trip, whereas the street car fares have to be added in the case of a steam trip, making the round fare 60 cents. Thus it figures out that the electric cars have knocked 45 cents off the average cost of a round trip, making it only one-third of what it was before under the old steam régime.

Such facts as these support us fully, we think, in our assertion made last week and on other occasions that in a few years all the "commuter" traffic around our great cities would be handled by electricity; and they also point significantly to the easy accomplishment of greater work beyond. It is noteworthy that the electric cars of the St. Paul–Minneapolis line have thus made their fight and won it, and put themselves on a paying basis, with inadequate facilities, and with all the drawbacks unavoidably incidental to a new traction service. In view of what has already been accomplished, President Lowry is substituting for the 30 h. p. motors others of 50 h. p. which will also haul trailers; and, if necessary, trains will be started from each city every minute, beside making greater speed.

This is the record of but two cities, but there are many others that can tell of like development through electricity, and it seems incredible that such a community as Brooklyn, with its great distances, should hesitate to avail itself of similar advantages. We doubt, however, whether the score or two of malcontents who have put themselves forward, can fairly claim to voice the intelligent sentiment of a community which is generally in no wise wanting in public spirit, civic pride, and an appreciation of science and art as applied to the welfare of the people.

TUNNEL LIGHTING AND VENTILATION.

THE bill of Senator Ahearn, which Governor Hill has approved, confers upon the New York State Board of Railroad Commissioners authority to compel the lighting and ventilation of all tunnels within the State, which are used by steam railroads. The Commissioners already had power in this direction, but the bill gives added weight to their recommendations, places a limit upon the time within which they must be complied with, and imposes severe penalities for any refusal or neglect to carry out the Board's suggestions. As our readers are aware, the Board has been looking into the matter of lighting, and has taken evidence on the subject. Some of that "evidence," directed against the electric light, has been of a very amusing nature, and it would appear that more than one intelligent man has still to discover the difference between arcs and incandescents. Pending action of the State Board, it is interesting to note that Mr. Paul H. Brangs, the electrical engineer of the Delaware, Lackawanna and Western Railroad, with other officials of that line, has lately been inspecting the plant in the Hoosac tunnel, with the view of adopting similar means, if satisfactory, for the Hoboken tunnel. The redeeming feature of the Hoosac tunnel, which is 5 miles long, is its method of lighting by incandescent lights, run on the alternating system and placed 40 feet apart. These allow work to be done with ease and facilitate the running of the trains, as the only other lights or signals of any kind are green ones used to designate the distance from the portals. Since the introduction of these lights no lives have been lost, whereas, formerly, brakemen and trackmen were often killed. The cost of the system is slight, being only about $30 per day of 24 hours, which includes all expense. The power is derived from two boilers and a [illegible] h. p. Corliss engine which runs three large dynamos constantly. There are 1,200 lamps of 16 c. p. in two rows, one on each side of the tunnel. It is said that under normal conditions the locomotive engineer can see the track nearly a mile ahead, and is in no way dazzled by the little incandescents. We trust Mr. Brangs may soon have the chance to be a pioneer in this work in this part of the country.

THE FRANKFORT ELECTRICAL EXHIBITION.

THIS week sees the beginning of the Frankfort Electrical Exhibition, the date of opening having been fixed for May 16; and while there was still much to be done, the show has at least made a start. It will probably not be in full running order for another month, and as it lasts until Fall, Americans who intend to visit it have plenty of time before them. There is every reason to believe that the exhibition will be a success, and that each of the twelve classes will be well filled. One of the most important pieces of work in connection with the exhibition is the long distance transmission of power from Lauffen to Frankfort, of which we have already given very full details. The experiments of Prof. Hertz will also be repeated and amplified. Special attention will also be paid to electric railroading, electric boating, and electric mining.

It is quite possible that the exhibition may furnish some suggestions for the electric exhibit at the Chicago World's Fair, which has seemed so far from being carried out on right lines that Mr. Edison has himself made the matter one of personal attention during a visit to Chicago. Prof. Barrett and Mr. Sargent both mean well, and have excellent ideas, but under existing arrangements they appear to have little opportunity to collaborate. But matters will soon straighten out, we hope, and promise better than they now do.

ELECTRIC HEATING.

IN tracing the history of an art, it is frequently instructive to compare it with other parallel arts, and to show in what manner the developments of the one follow closely upon those of the other. It was but a comparatively short time after the recognition of the method of producing light from electricity on a commercial scale that the availability of the same source of energy for heating purposes, both special and general, was recognized. Naturally the arc as a source of heat attracted most prominence, and not a few electric furnaces were constructed on this principle. Next came the employment of resistances heated up by the passage of the current and employed in a variety of ways for the heating of cars and many kinds of special apparatus. In this issue we draw attention to the third method, which may be said to present a close anology to what are termed semi-incandescent lamps of the Werderman type. In this method of heating, devised by Mr. Zipernowsky, heat is produced by the resistance caused by bad contact, the materials of which the contacts are formed being such as to withstand the action of the heat generated. It is evident that this method would not of itself give rise to an increased efficiency over a form in which wire resistances are employed, but it may under certain circumstances permit of the production of a higher degree of heat with a compact arrangement of parts.

PLATINUM LEADING-IN WIRES.

SOME time ago in referring to the improvements in lamp manufacture which had made it possible to reduce the price of incandescent lamps over 66 per cent. within a comparatively short space of time, we drew attention to the increasing cost of platinum and its effect upon the cost of manufacture of such lamps. The most natural remedy for the reduction of this item of expense would be the substitution of some other material for it; but as some one has naïvely remarked, the substitute for platinum which has all its characteristics and is able to withstand the tests of platinum, *is* platinum. A substitute being, therefore, still a thing of the future, the only way out was to reduce the quantity of platinum required for the leading-in wires. What can be accomplished in this way is well shown in the progressive stages of incandescent lamp manufacture exhibited on another page. Whereas formerly but a few hundred lamps required an ounce of platinum wire, at present as many thousands can be effectually sealed by the use of the same weight of material. It may, perhaps, be due to such economies as these that the price of platinum has lately fallen from its very high figure of the past year or two.

Standard Cells.

THE working electrician naturally feels ill at ease when in doubt as to the accuracy of indication of his working instruments, and hence desires to have at hand some convenient standard by which to test their accuracy. The standard cell is one of the most convenient and handy of such reference standards, and any improvement which can increase or ensure its accuracy, as well as permanence, is therefore worthy of special consideration. Our readers will therefore be interested in the modification introduced by Mr. Carl Hering, which we describe in another column, and in which he overcomes some of the difficulties heretofore encountered by constantly renewing the surface of contact between the two solutions employed, and thus preventing their mixture. While voltaic cells of various construction still remain the most reliable of working standards, their use is nevertheless accompanied by not a few inconveniences. A standard of E. M. F. which shall be simple in construction and permanent in its indications under all conditions, will therefore be a great step in advance, and will, we believe, be soon forthcoming.

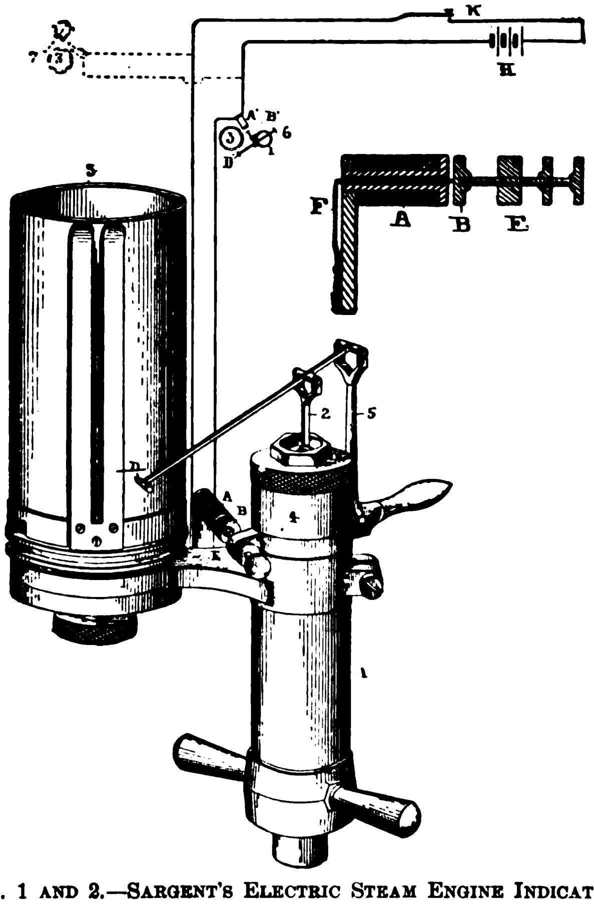
The New York Subways.

THE New York Board of Electrical Control has had the term of its existence lengthened, and has now taken an important step in dividing up the work done under its supervision. The old Consolidated Subway Co. is to restrict itself to high tension conduit building, while the new Empire City Subway Co. is to do all the low tension work, including telegraph, telephone and incandescent lighting. In other words, the new company becomes a dominant, controlling factor. Why it should have been necessary thus to split up the work we cannot quite see, but an explanation could probably be obtained from Tammany Hall if it chose to give one.

SARGENT'S ELECTRIC STEAM ENGINE INDICATOR.

In the case of a triple expansion engine with indicators placed on the ends of each cylinder it is desirable, in order to obtain accuracy, to indicate the several cylinders at exactly the same instant. Heretofore it has been practically impossible to operate the several indicators employed, at exactly the same moment, and for the same period of time, as each indicator was separately controlled. With these facts in mind, Mr. Frederick Sargent, the well-known electrical engineer of Chicago, has provided a means whereby the recording devices of several indicators can be operated from a distance at the same instant by one person, and the time of contact at each indicator be made of exactly the same duration.

The manner in which this has been accomplished is shown in the accompanying illustrations, Fig. 1 being a perspective view of the indicator, and Fig. 2 a sectional view of the operating magnet. As will be readily understood, A is an electro-magnet in circuit with a battery, and the key K. The armature, B, is fixed upon the movable sleeve of the indicator cylinder, by turning which the pencil is brought into contact with the paper on the drum. The armature is normally held away from the end of the magnet, and hence, also, the pencil from the drum, by means of the spring F, Fig. 2. When the circuit is closed, however, the sleeve is drawn around, the pencil is pressed against the paper on the drum, and the card taken.



Figs. 1 and 2.—Sargent's Electric Steam Engine Indicator.

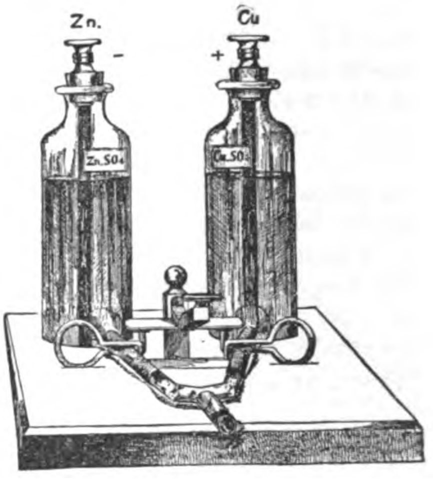
It is evident that a number of these magnets may be placed on the same circuit as shown in Fig. 1, and that by this means the indicators will all be operated at exactly the same instant, by merely closing a single key.

Mr. William Morehead, who has been connected with the electric light company at Ogden, Utah, for some time past, has accepted the position of electric light inspector at Salt Lake.

A NEW FORM OF STANDARD CELL.[1]

BY CARL HERING.

In a number of forms of battery cell in which two bottles or reservoirs are connected together by a tube, the mixing takes place quite rapidly, unless the pressure of the liquid is exactly the same in both bottles, a condition not always easily complied with. Some time ago the writer had occasion to use a cell of this form devised by Prof. Barker, which consisted of two bottles containing the two liquids with their respective electrodes, the bottles being connected at their bottoms by a small tube with a stopcock. This cock was opened only during the moment when the cell was being used. But even during a few seconds no small amount of mixing took place, especially if the pressure was different in the two bottles. It is very difficult to avoid this difference of pressure, owing to the different specific gravities of the liquids, and their different heights in the two bottles. The writer therefore modified this form by inserting two stopcocks in this tube and allowing the portion of the tube between the two cocks to communicate directly with the air, as shown in the accompanying engraving. Thus the liquids, which mix at their point of contact, are allowed to drain off as rapidly as they mix. As there is an outward flow of the liquids through the cocks, the mixed liquids cannot pass back into the bottles. The liquids in contact with the electrodes will therefore always remain pure. To prevent too rapid a flow, which would needlessly waste the liquids, some filter paper, cotton or asbestos is packed into the tubes. The intermediate tube may be drained completely, as there is always a film of liquid sufficient to answer for a contact if the cell is used on open circuit, which is the only way any standard cell should be used. It was even found that the film of liquid through the cocks when closed, was sufficient to give an electro-motive force, which, however, falls as soon as the slightest current is allowed to flow. The internal resistance of such a cell is naturally quite high, from 10,000 to 20,000 ohms, but this is no disadvantage for the usual class of open circuit testing.



Hering's Standard Cell.

Such a cell may be kept standing indefinitely, and is always ready for use. A quantity of zinc scrap should be kept in the bottle containing the zinc solution, and copper scrap in the other, both out of contact with the electrodes, for the purpose of freeing the liquids of impurities, should any mixing occur.

In experimenting with this cell, it was found that the slightest pressure upon the corks produced decided differences of potential in the E. M. F. of the cell. It was, therefore, found necessary to use corks with holes through them to prevent pressure from being exerted upon the surface of the liquid.

CREAGHEAD ENGINEERING CO.

The Creaghead Engineering Co., of 99 West Fourth street, Cincinnati, O., was incorporated in Covington, Ky., some weeks ago. At present they do not expect to do any manufacturing business, but are simply acting as agents for manufacturers, dealing in electrical supplies of all kinds, in addition to which they act as consulting and contracting engineers for all kinds of electrical plants. They are also the accredited representatives of the Westinghouse systems there. It is within the range of possibilities that they may begin the manufacture of electrical specialties in the near future. The officers of the company are: H. D. Emerson, president; Thos. J. Creaghead, vice-president, and C. L. McCrea, treasurer.

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[1] Abstract of a paper read before the Electrical Section of the Franklin Institute.

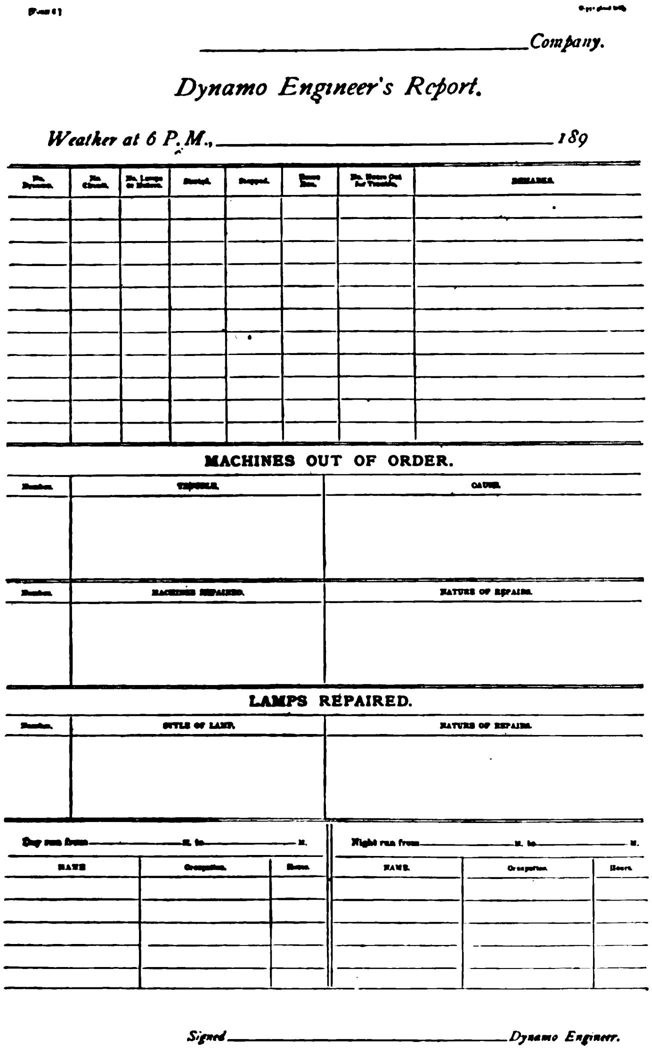
CENTRAL STATION MANAGEMENT AND FINANCE.—V.

BY

Horatio A. Foster

Electrical Department.

From all the reports mentioned last week, the Dynamo Engineer gathers data for his own which is somewhat contracted, and does not of necessity contain much of any of them. No. 6 and 6A are two sizes of this, and contain place for mention of names, time of employees, and the times of the different runs, as well as time of starting and stopping dynamos, this last being taken from the arc switchboard list, and report of dynamo tender as to the running of the other machines. In this again, as in the Chief Engineer's report, the storeroom is depended on for a statement of supplies used.



[Form 6.] Copyrighted 1891.

____________________ *Company.*

Dynamo Engineer's Report.

Weather at 6 P.M., ____________________ *189*

No. Dynamo.	No. Circuits.	No. Lamps or Motors.	Started.	Stopped.	Hours Run.	No. Hours Out for Trouble.	REMARKS.

MACHINES OUT OF ORDER.

Number.	TROUBLE.	CAUSE.

Number.	MACHINES REPAIRED.	NATURE OF REPAIRS.

LAMPS REPAIRED.

Number.	STYLE OF LAMP.	NATURE OF REPAIRS.

Day run from ________ M. to ________ M. | Night run from ________ M. to ________ M.

NAME.	Occupation.	Hours.	NAME.	Occupation.	Hours.

Signed ____________________ *Dynamo Engineer.*

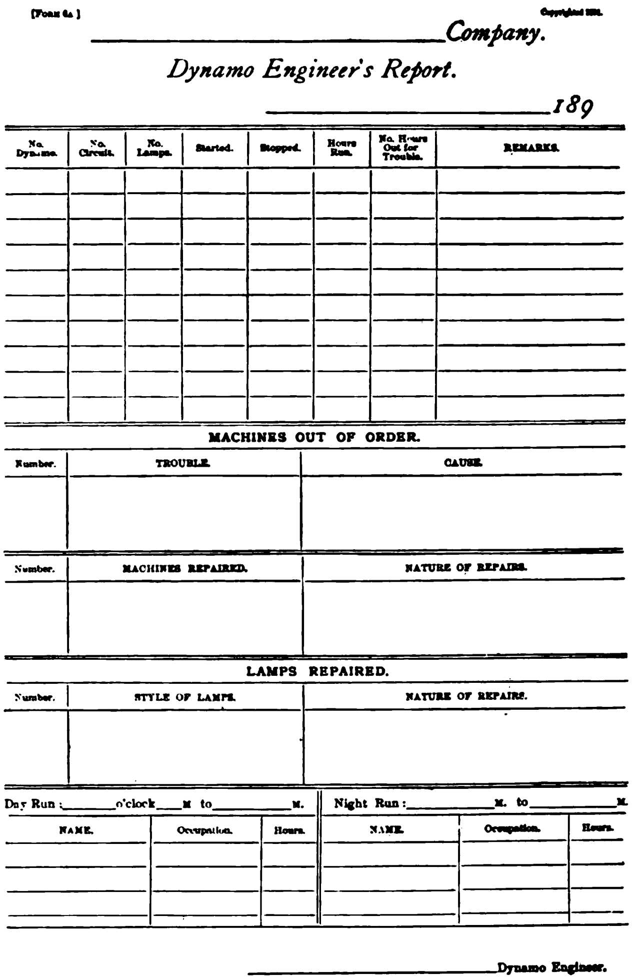
BLANK NO. 6.—DYNAMO ENGINEER'S REPORT.

Superintendent's Report.

From the department reports the superintendent makes his report on blank No. 9. This is a general résumé of the reports of chief engineer and dynamo engineer, together with reports of new contracts and such data taken from the office. It serves to state as briefly as possible the general condition of the station departments to the officials in authority. It serves also to record any changes or other matter which it is well to note for future reference.

Storeroom.

The supply department in stations large enough to afford it should have a good storekeeper, one who can keep clean records and make out his reports accurately and on time. In smaller places this department is easily attended to by the office clerk, and in his absence on collections or other duties the key can be turned over to some member of the day force around the station. As all orders for supplies must be accompanied by the proper requisition from foreman (blank No. 10) all material is easily accounted for. It is very important that the foremen or department head should sign all supply orders for construction material as it many times saves dispute.



[Form 6a.] Copyrighted 1891.

____________________ *Company.*

Dynamo Engineer's Report.

____________________ *189*

No. Dynamo.	No. Circuits.	No. Lamps.	Started.	Stopped.	Hours Run.	No. Hours Out for Trouble.	REMARKS.

MACHINES OUT OF ORDER.

Number.	TROUBLE.	CAUSE.

Number.	MACHINES REPAIRED.	NATURE OF REPAIRS.

LAMPS REPAIRED.

Number.	STYLE OF LAMPS.	NATURE OF REPAIRS.

Day Run: ______ o'clock ____ M. to ________ M. | Night Run: ________ M. to ________ M.

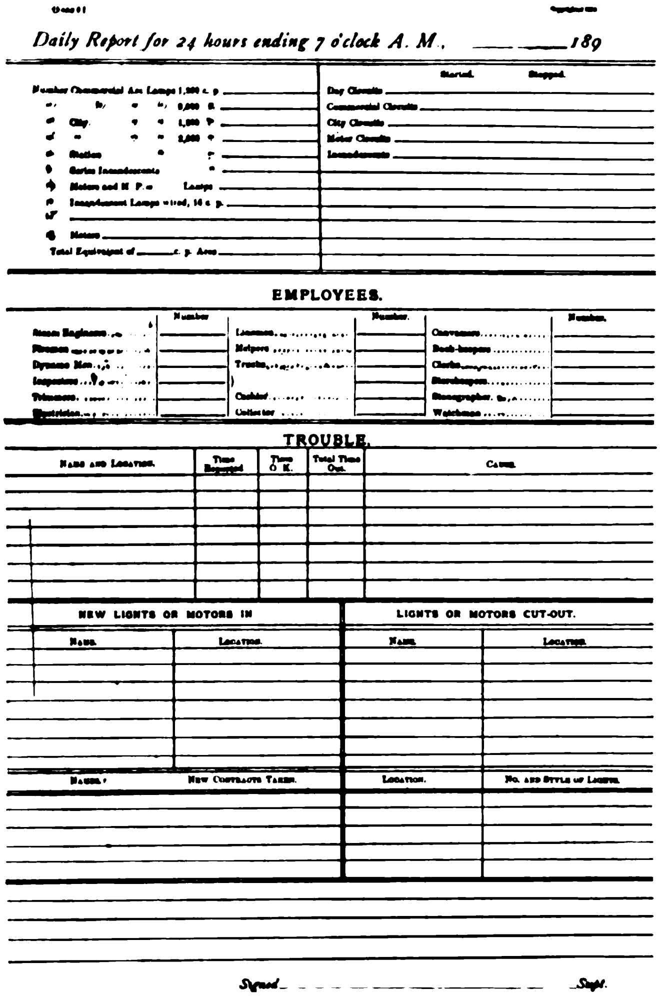
NAME.	Occupation.	Hours.	NAME.	Occupation.	Hours.

____________________ Dynamo Engineer.

BLANK NO. 6A.—DYNAMO ENGINEER'S REPORT.

In the case of the general operating supplies, such as carbons, waste, oil, etc., a supply order is written and signed by the man who gets the material, and it must show the proper order number of the department for which it is intended. Figures of coal and water supply are taken from the engineer's daily report.

The storekeeper's records are a receiving book in which are entered all supplies received, stating date received, whom from, items and any unusual particulars. This book comes in very handily in checking up bills, and is also very convenient for future reference. A delivery book is needed also on which are entered all supplies drawn out on requisition of the foremen and operating departments, it being made up from the requisition tickets, and in case of a large breakage of incandescent lamps, it is very convenient to keep a register of such lamps, giving the name of the customer and having a number of columns, say, one for each month, thus showing at what point in a circuit the lamp breakage may be excessive, and at the same time, the part of the year when it is the heaviest. Such a record also gives a good basis on which to calculate the average life of lamps. Each incandescent lamp taken from the storeroom should be accounted for by the return of either an unbroken lamp or its base.



Daily Report for 24 hours ending 7 o'clock A. M., ______ 189

		Started.	Stopped.
Number Commercial Arc Lamps 1,200 c. p.		Day Circuits	
" " " " 2,000 "		Commercial Circuits	
" City " " 1,200 "		City Circuits	
" " " " 2,000 "		Meter Circuits	
" Station " "		Incandescents	
" Series Incandescents "			
" Motors and H. P. Lamps			
" Incandescent Lamps wired, 16 c. p.			
"			
" Meters			
Total Equivalent of ______ c. p. Arcs			

EMPLOYEES.

	Number		Number.		Number.
Steam Engineers		Linemen		Canvassers	
Firemen		Helpers		Book-keepers	
Dynamo Men		Trucks		Clerks	
Inspectors				Storekeepers	
Trimmers		Cashier		Stenographer	
Electricians		Collector		Watchmen	

TROUBLE.

Name and Location.	Time Reported	Time O K.	Total Time Out.	Cause.

NEW LIGHTS OR MOTORS IN		LIGHTS OR MOTORS CUT-OUT.	
Name.	Location.	Name.	Location.

Names.	New Contracts Taken.	Location.	No. and Style of Lamps.

Signed ______ Supt.

BLANK NO. 9.—SUPERINTENDENT'S REPORT.

[FORM 10.] Copyrighted 1891.

STOREHOUSE ORDER.

______ Company.

______ 189

Please deliver to bearer for

______ *Order No.* ______

______

______

Foreman.

BLANK NO. 10.—STOREHOUSE ORDER.

CHLORINE IN HYDROCHLORIC BICHROMATE BATTERIES.

BY

Chas. J. Reed

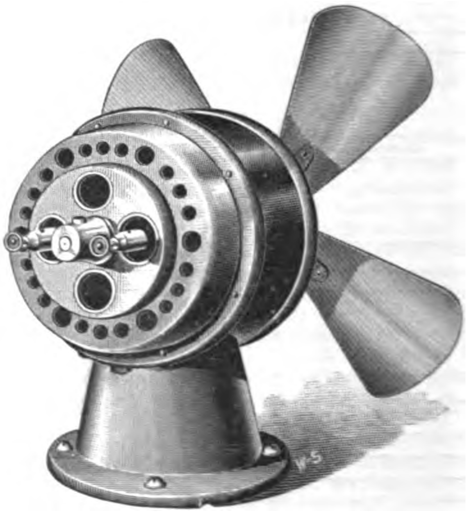
IN THE ELECTRICAL ENGINEER of May 13th, Mr. Steinmetz points out that he was unable to find free chlorine in the bichromate cell in which hydrochloric acid is present, and states that the reduction of chromic acid by hydrochloric does not take place in the cold.

Some years ago the writer had occasion to investigate this subject, and found that the reduction *does* take place at all temperatures above the freezing point. The action is not very rapid at low temperatures, especially with dilute solutions, such as were probably used by Mr. Steinmetz. When the concentrated solutions, cooled to 0° C., are mixed one drop at a time in a thin layer on the bottom of a flat evaporating dish surrounded by melting ice, sufficient chlorine is evolved to almost instantly discharge the color of litmus and other organic coloring matters. Very dilute solutions will do the same if sufficient time is allowed.

I am glad to learn that in the battery solution, this evolution of chlorine is not fast enough to be objectionable. It would be still more interesting, however, to know whether tools and instruments would not be seriously corroded by standing two or three months in the same room with an open battery of this kind.

THE NEW MESTON ALTERNATING CURRENT FAN MOTOR.

THE question of designing an economical and efficient motor for operation from a source of alternating current is one which has recently received a vast amount of attention, and many forms, more or less complicated, have been brought out. For fan work, it is especially desirable to be enabled to use a motor operated by an alternating current, and it is just as desirable that the motor should be efficient and of light weight in proportion to the power developed for running fans as for any other heavier work. The new motor, shown in the accompanying illustration, is manufactured by The Emerson Electric Mfg. Company, of St. Louis, Mo. It fulfills all the above-mentioned requirements in the highest degree. It is, of course, self-starting, always running in the pre-determined direction and never exhibiting the persistent disposition to stand still, which has been noticeable in some of the alternating motors proposed and which required to be started by hand. It runs at 2,500 revolutions, absorbing 1.8 amp. on 52 volt circuit. It is extremely simply constructed and develops $\frac{1}{8}$ h. p. and will operate equally well either on direct current incandescent, arc or alternating circuits. The mechanical workmanship is of the best, and the whole machine is most compact, neat and reliable.



THE MESTON ALTERNATING MOTOR.

THE NEW WESTERN UNION HEADQUARTERS AT ST. LOUIS.

BY

RJ Hewett

SOME sixteen months ago the main office of the Western Union Telegraph Co. was destroyed by fire. Since that time the company have occupied temporary quarters at 215 Pine street. Last fall the Lucas building, on the south side of Pine street, between Fourth and Broadway, was selected for permanent quarters and the work of alteration and fitting up was inaugurated and pushed forward with vigor. On Monday, May 11th, the building was finished and occupied by the several departments. The receiving department, manager's office and book-keepers, occupy the first floor. The second floor is occupied by the division superintendent, Mr. L. C. Baker, and the several departments pertaining to his division. The third floor is occupied by the Gold and Stock Telegraph, cloak rooms, lunch counter, lavatories, lamp room and also as a distribution room for the instrument cables of the operating room. The fourth floor is occupied by the operating department.

The power plant is located in the basement of the building, which is 135 feet long by 36 feet wide and 11 feet high. The basement is divided into three divisions, the front being for the linemen, the middle portion is occupied by the engine and dynamo plant, and the rear portion by the boilers. The basement is floored with granitoid throughout. Steam is supplied by two plain tubular boilers, each 16 feet in length with 66 inch shells, capable of carrying 100 pounds pressure. They are fitted with high and low water alarms and damper regulators. Two Deane duplex steam pumps supply feed water.

The engine and dynamo room is 36 by 47 feet, and as it contains the most interesting electrical feature about the building it will be described more fully. A Rice automatic engine of 85 h. p. capacity drives a 400 light U. S. dynamo which supplies lights throughout the building. Three Rice automatic engines, each of 15 h. p., drive three gangs of telegraph dynamos. One upright engine drives two Root blowers for operating the pneumatic tubes. There is also an elevator engine and a small 5 h. p. upright engine for driving ventilating fans. All engine cylinders are lubricated from a large oil tank in the boiler room, the oil being forced into the main supply pipe by steam pressure. All steam pipes are covered with the Flegel air space covering.

Each 15 h. p. engine is belted to a separate line shaft to which is belted a gang of 5 or 7 telegraph dynamos. The line shafting is supported entirely independent of the building by means of an iron framework supported on iron pillars anchored into concrete foundations, the pillars being connected together at the top by I beams and the shafting hung to heavy wood cleats attached to channel beams. This arrangement prevents noise or vibration being communicated to the building, besides adding to the general stability of the gearing. The shafting pulleys and pulley hubs are all highly finished. The pulleys which drive the local circuit and loop circuit dynamos are provided with friction clutches supplied by the Fall River Manufacturing Co., all other pulleys being fixed rigidly to the shaft.

Each gang of dynamos is mounted on a heavy wooden bed-plate which is bolted to a concrete foundation, the top of the bed-plate being 20 inches above the floor.

Nineteen telegraph dynamos, supplied by the C. & C. Electric Motor Co., are arranged in three gangs, two gangs of seven and one gang of five. The two gangs of seven are each arranged into sections for supplying main line circuits, local circuits and loop circuits. Five dynamos of each gang are connected in series and supply the main lines, the sixth dynamo supplies the loop circuits, and the seventh supplies the local circuits. Two main circuit sections supply positive and negative current to main lines, one section having its positive pole connected permanently to earth and its negative pole to the switchboard, while the other section is arranged in a reverse manner: that is, its negative pole is connected to earth and its positive pole to the switchboard.

One set of loop and local circuit dynamos have ample capacity for supplying all circuits, the other set being held in reserve.

The third gang of five dynamos is a reserve main line set, all five being connected in series. The series dynamos are wound for a potential of 80 volts, at a speed of 1,250 revolutions, but ordinarily will be run at 70 volts. A set will, therefore, give the following potentials: 70, 140, 210, 280 and 350 volts. The loop dynamos are wound for 30 volts at a speed of 1,250 revolutions, but will be run at 25 volts. The local circuit dynamos are wound for 10 volts at a speed of 1,250 revolutions and will be run at six volts. The current capacity of the dynamos is as follows: Main line dynamos, 20 amperes; loop dynamos, 50 amperes, and local dynamos, 150 amperes.

The fields of the series dynamos of each set are excited by the fifth potential dynamo, each field having a regulating resistance box in circuit with it giving independent regulation for each dynamo. Regulation can also be effected by changing the potential of the fifth dynamo. The reserve gang of five dynamos is arranged so as to supply positive or negative current to line as the emergency may require. This is done by simply reversing the connections of the exciting circuit, which thereby reverses the fields of all four dynamos; the leads of the exciting dynamo being reversed at the same time, its fields thereby remain permanent.

The dynamos are connected to the switchboard by leads laid in moulding attached to the side of the concrete foundations, and running overhead from the end of the foundation to the switchboard where they connect by plug switches with leads to the lamp room on the third floor immediately underneath the switchboard of the operating room.

In shifting from one gang to another, in order to avoid interruption of current, the set to be put into service is first brought to the same potential as the working set, and then thrown into multiple with it, and the set which is to be relieved is then thrown open leaving the remaining set to furnish the current. The local and loop dynamos of the other gang are brought into service by means of the friction clutches.

On a large switchboard, 30 feet long by 6 feet 10 inches high, are mounted the regulating resistance boxes, voltmeters, reversing switches and steam guages. There are three high reading voltmeters for the series sets of dynamos, and three low reading voltmeters for use on the local and loop dynamos, and also for taking the reading on a single dynamo. Readings are taken from the 280 volt potential, and also from the exciting dynamo by which means any variation can be noted and corrected.

The lighting dynamo is provided with an ammeter and a potential indicator, also switches, fuses and other usual accessories. All test instruments are from the well-known Weston Electrical Instrument Co. of Newark, N. J.

A Bristol recording pressure guage registers the boiler pressure which is checked by an ordinary pressure guage. There are also pressure gauges for the heating system and the exhaust.

The lamp room is located on the third floor immediately below the main switchboard. The current from each potential lead is subdivided by passing through a number of sets of incandescent lamps which reduces the current to a maximum of about half an ampere for each line, there being a separate set of lamps for each line. The fourth and fifth potential currents pass through sets of three lamps in series, the second and third potentials through sets of two lamps in series, and the first potential through sets of single lamps. Each set of lamps is connected to battery discs on the main switchboard in the operating room. The usual horizontal battery bars on the back of the board are not used. Each battery disc supplies only one line. Notwithstanding these changes on the back of the board, all battery manipulations on the face of the board are carried out in the same manner as would be the case with continuous battery bars. Each horizontal row of battery discs is treated as a battery bar of a certain potential.

The operating room, located on the fourth floor, is 37½ feet wide by 125 feet long and 23 feet in height. It is well lighted by windows on all four sides and also by two ventilating sky lights in the roof. The roof is of the truss pattern, and is supported independently of the walls of the building by means of iron columns extending to the basement foundation.

The switchboard is located in the east side of the room and is 22 feet in length by 10 feet in height, and 8 feet deep, and is composed of seven sections. Five sections are each fitted with 50 wire standard W. U. spring jack switchboards accommodating 250 wires. Two sections are fitted with two loop jackboards, each accomodating 100 loops for switching, quadruplex and duplex sending and receiving local circuits and city loops.

All instrument wires are in Kerite cables run through the floor and carried along the ceiling below the operating room in wooden cleats attached to iron hangers.

The table equipment consists of 28 octette tables, 6 quartette tables and 7 Wheatstone tables. The table equipment is sufficient to accommodate 275 operators. The instrument equipment consists of 25 quad sets, 10 duplex sets, 3 Wheatstone sets and 115 single sets.

The building is provided with an elaborate system of pneumatic tubes, aside from the pneumatic tube service to the Merchants Exchange, and is thoroughly lighted with arc and incandescent lights, the Ward arc lamp being used on the incandescent circuits.

A steam elevator extends from the basement to the operating room. Some 3500 feet of new Kerite cable has been erected, covering all of the down town portion of their territory.

The installation has been carried out under the personal supervision of Mr. L. L. Summers, Assistant Electrician, W. U. T. Co., Chicago; Mr. H. S. Graber, Chief Engineer, St. Louis; and Mr. A. E. Van Tyne, Electrician of the St. Louis office, aided by a staff of able assistants. It is a model of excellence in telegraph engineering work.

NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS.[1]—II.

(*Concluded.*)

BY W. B. ESSON.

OUTPUT OF ALTERNATING CURRENT ARMATURES.

THE armature leads for alternators, though producing a cross magnetization, as in direct-current machines, raise no considerations, of course, as regards sparking. But on account of the greater proximity of the poles, and the greater stray field resulting, it is desirable to make the layer of copper on the armature core as thin, and the air gaps as short, as possible. As a consequence, probably, of the increased ratio of stray to useful field, the induction is less in the gaps of alternating than in those of direct-current machines. Some comparisons have been made of the output of direct and alternating machines of the same weight, but these, in the nature of things, must be misleading. The two types are quite unlike in their proportions, as Figs. 1 and 2 show, and no one would think of making them the same. Fig. 1 represents the magnetic system of a four-pole direct and Fig. 2 that of a twelve-pole alternating machine of the same output; and while it will be observed that the iron parts—core and yoke-rings—are much heavier in the former, it will be noticed that the copper in the magnet coils is much heavier in the latter. In fact, though the iron in the alternator is only 55 per cent. of that in the direct-current machine, the copper required is no less than 250 per cent. It is difficult, then, to understand what useful purpose is served by comparisons such as I have alluded to.

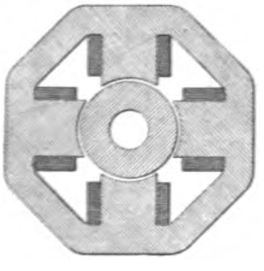


FIG. 1.

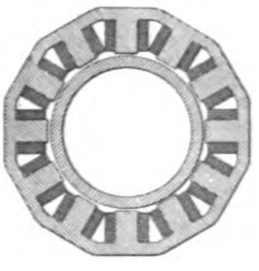


FIG. 2.

RELATION OF AIR GAP TO DIAMETER OF ARMATURE AND NUMBER OF POLES IN DIRECT-CURRENT MACHINES.

Having established the proportionality of the volume and diameter, it is easy to find the relation which must exist between the diameter and length of air gap for any particular angle of embrace, in order that sparking may not occur.

But, as is also seen from the equation, the gap required for any particular volume is proportional to the angle of embrace, and if we substitute for two poles a greater number, of correspondingly less angular width, working with an increased diameter and volume without a proportionally increased gap is made possible. This is where the advantage of the four, six or even eight pole machine comes in.

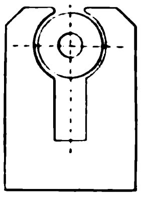


FIG. 3.

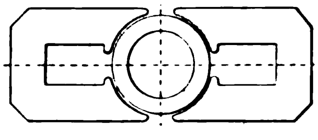


FIG. 4.

DIMENSIONS OF THE ARMATURE.

It has been observed that the output of an armature is proportional to d^2 L; and the induction being the same, the weight of the core for a given number of poles must be proportional to the output, the radial depth increasing directly as the diameter, so that a proportionally increased field may be carried. The number of poles being fixed, the weight of the core for a given output may be taken, therefore, as approximately constant, whatever the ratio of L to *d*.

The power wasted in hysteresis is proportional to the weight of iron magnetized, and to the number of reversals per second. The weight being inversely, and the reversals directly, as the number of poles, the power wasted is for a given output the same.

So much for the core; let us now consider the copper part. Taking Gramme-wound armatures having an interior opening equal to .66, or two-thirds of the core diameter, it is found—the output, speed, and temperature being predetermined—that the ratio of L to *d* may vary through a considerable range without making any great difference in the weight of copper or efficiency.

All the above facts go to prove that if there is anything to be gained, as regards the production of the field, by increasing the diameter of the armature and the number of poles, there is nothing, considering the armature by itself, to be lost by it. It may, in fact, be rather an advantage, because the weight of the iron core is reduced. It is true the peripheral velocity is increased; but this does not matter in the least, provided a certain limit is not exceeded. Opinions differ as to what the limit should be, some machines working at 50 ft. per second, others at 100 ft., and a few as high as 125 ft.

DIMENSIONS OF THE FIELD MAGNETS.

It will be apparent, from the foregoing considerations, that the employment of two or more than two poles for direct-current machines of moderate dimensions resolves itself mainly into a deliberation regarding the most economical shape to give to the field magnets.

I have said that for the prevention of sparking it is necessary that, the induction per square centimetre remaining the same, the air gap increases proportionally to the diameter, whether the space is necessary for conductors and clearance or not, but that the coefficient by which the diameter has to be multiplied to give the length of the gap necessary to prevent sparking diminishes directly as the pole angle. In comparing the magnetic system of a four or six-pole machine with that of a two-pole one, it is necessary to adopt dimensions for the armature in accordance with the considerations already mentioned; hence, if the two-pole armature had a length of core equal to one and a half times its diameter, in a four-pole one the length should be about half the diameter. The diagrams Figs. 3 and 4 show the cross sections of two such machines. The diameter of the four-pole armature is 1.4, and its length .5 times that of the two-pole one, consequently both machines give the same output. The weight of the two horse-shoe magnets in the four-pole machine comes to 56 per cent. of the weight of single horse-shoe magnet, which indicates in this particular case a considerable saving in wrought iron. In taking the copper weight it is necessary to bear in mind that this does not vary simply as the length of the wire if the machines are of the same efficiency, but as the square of the length; so in this particular comparison the copper on the two horse-shoe would be, roughly, 30 per cent. more than on the single horse-shoe, assuming the length of the air gaps to be the same.

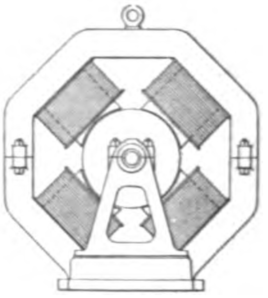


FIG. 5.

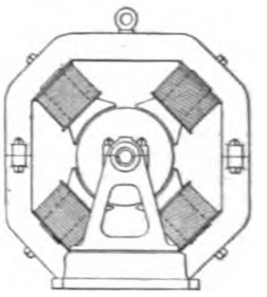


FIG. 6.

When we come to machines of a certain size, there is undoubtedly a gain in employing more than two poles, while very large machines become impossible of construction with two poles only. But to go beyond four poles in many cases would be a mistake, Increasing the poles always results in an actual increase in copper, unless at the same time the power spent in the gap is reduced, and this latter must be effected without reducing the thickness of the armature winding.

Having discussed the design of multipolar machines as influenced by both theory and practice, it remains to conclude this communication by calling attention to some of the ordinary forms of multipolar fields. The double wrought iron horse-shoe Fig. 4 is not very frequently used, being rather costly. Fig. 5 is a form designed by Gramme in 1885, and since adopted for cylinder-wound armatures by many makers, including Mr. Jasper, in Belgium; Mr. Brown of the Oerlikon Works, in Switzerland; and Messrs. Paterson & Cooper, in England. Fig. 6 represents a similar field in which the magnet cores are of wrought iron, fitted with cast iron pole-pieces, as used by Mr. Kapp. The decision as to whether cast iron or wrought iron should be used is arrived at in a very simple manner—by comparing the excess of copper required on one hand with the extra machining required on the other.

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[1] Abstract of a paper read before the Institution of Electrical Engineers.

All these are examples of single magnetic circuits, where the lines of force from each pole remain undivided in their paths through the magnetizing coils; but in Figs. 7 and 8 are shown examples of double magnetic circuits, in which the lines from each pole take two paths through separate coils. Fig. 7 is a type of magnet used by Sautter-Lemmonier, of Paris, for Gramme-wound armatures, and by Cuenod-Sautter, of Geneva, for armatures having a Siemens winding as modified by Thury. It looks at first sight as if the weight of copper were not very different in the two types, but in this respect appearances are deceptive, for, as a matter of fact, the field of a four-pole machine made to Fig. 7 would require about 125 per cent. more copper than if made according to Fig. 6. It will be observed, however, that the magnet cores and pole pieces, which are made throughout of the softest wrought iron, are very light. In Fig. 8 the magnets are a series of wrought iron bars lying parallel to the armature, each fitted with a cast pole-piece in the middle of its length, and having two magnetizing coils, one on each side of this piece. It is a structure which may be frequently met with, though not precisely in the form shown, and the observations regarding the copper made with reference to Fig. 7 apply equally here.

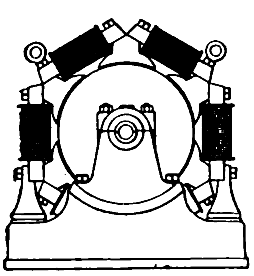


Fig. 7.

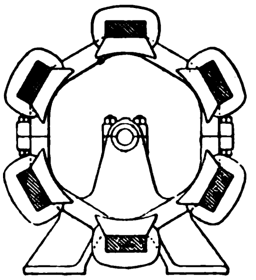


Fig. 8.

The fields of alternators may be similarly divided into those having single and those having double magnetic circuits; the former requiring, as in the fields of direct-current machines, much less copper than the latter. Amongst those having single magnetic circuits are the machines of Siemens, Ferranti, Mordey, Westinghouse, Elwell-Parker, and Paterson & Cooper. Mr. Kapp possesses the distinction of having the only alternator with double magnetic circuits.

BATHURST'S CROSS OVER BLOCK.

Any one who has had experience in the running of wires in buildings either as "cleat" or "molding" work, must have felt the need of a suitable device to facilitate and ensure a safe crossing of wires of different polarity, for, no matter how carefully the arrangement of the wires may have been thought out there must, and will, be points in the installation at which a "return" wire has to cross over, or under, a "leading" wire; and although the wires are drawn in the diagram as crossing without touching, this being usually shown by a small semi-circle, it will be in the experience of every electrician as to the number of these "crossings" that have been of an unsatisfactory and dubious character. In cleat work, perhaps a piece of asbestos paper has been put between the wires, and in molding work one may have been taken either at the back of the wooden molding on the bare brick or plaster, or passed exposed to view over the cover. We illustrate in the accompanying engravings an improvement, patented by Mr. Fred Bathurst, of Schenectady, upon the ordinary way of taking branches off mains and crossing wires in electric circuits.

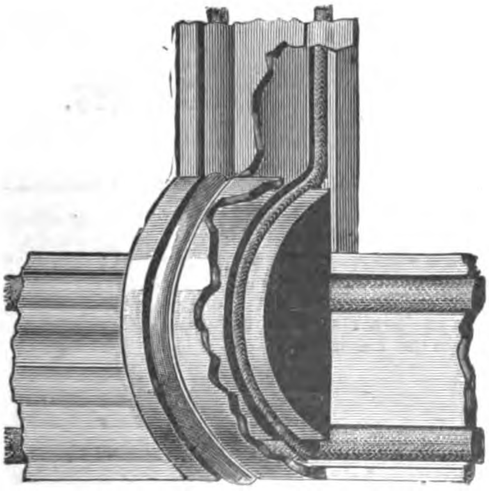


Fig. 1.—Bathurst Cross Over Block.

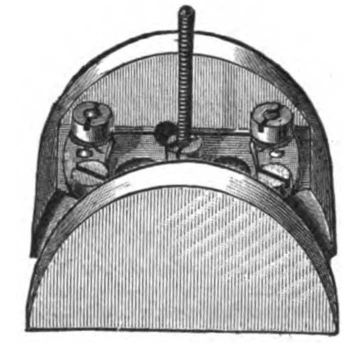


Fig. 2.—Bathurst Cross Over Block.

Fig. 1 shows the application of a wooden block to molding work, and Figs. 2 and 3 a porcelain block as arranged for the insertion of a fuse in the circuit, as will be the case where the crossing wire is a branch from a main. The blocks, which combine neatness with efficiency, were introduced in England a short time ago, and are slowly but surely finding favor there, but we predict that with our American enterprise and absence of conservatism and for old methods, their merits will soon be recognized by our electricians, and a ready market for them will follow.

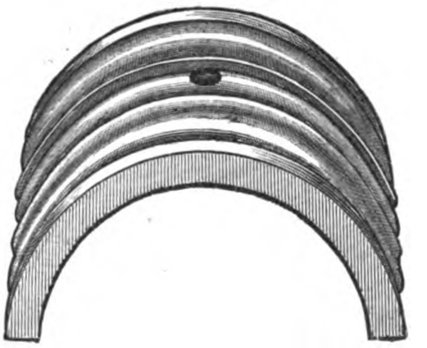


Fig. 3.—Bathurst Cross Over Block.

FRANKFORT EXHIBITION OFFICIAL JOURNAL.

By order of the board of directors of the international electrical exhibition in Frankfort, an official paper is to be published under the title of *Elektricität*. It is to appear in weekly issues, and will be edited by Dr. Max Quarck and H. Massenbach, engineer in Frankfort. It will be the mouthpiece for the official reports of all the particulars of the electro-technical exhibition. The journal will bring before its readers a history of the origin and course of the exhibition, a complete representation of the present state and prospects of electro-technics, an authentic report of the work of the juries and the consultations of the professional congresses which are to meet during the exhibition, as well as carefully selected, reliable reports and discussions on the exhibits. The *Elektricität Officielle Ausstellungszeitung*, will also contain original papers, detailed reports and notices, and will be illustrated by engravings, sketches, and plans. It will be published weekly, commencing on April 15th, and there will be altogether 30 issues, each having at least three sheets. When finished it is expected to form a worthy memorial of the present state of electrical science and of the international exhibition at Frankfort.

Mr. H. A. Loomis has been appointed superintendent of the Manitou Beach, N. Y., electric railway. About five miles of track are now laid, and the engines and boilers are in position in the power house.

Letters to the Editor.

OIL AS AN INSULATOR FOR HIGH TENSION TRANSFORMERS.

In the issue of the THE ELECTRICAL ENGINEER, of April 15, 1891, No. 154, you publish a letter, signed by Prof. Elihu Thomson, referring to your article in No. 153 on the use of oil in high tension transformers.

The tone of the letter would imply that I had encroached on a Patent, No. 428,648, issued in May, 1890; the claim in this patent is for the use of oil as a means of conveying the heat from the coils to the outer casing of the transformer, and not specially for insulating, as, no doubt, Prof. Thomson well knew that, as far back as 1880, Brooks employed oil for insulating purposes in a mode quite similar to that described in the patent above referred to.

I never claimed to be the first to use oil for insulating and have stated in my paper read in Frankfort-on-the-Main, February 9, 1891, and published in the *Elektrotechnische Zeitschrift*, No. 11, 1891, my opinion that Brooks was the first to advocate and use oil for insulating.

What I claim is, that I was the first to perceive and put into practice the idea that by means of oil it was possible to make commercial transformers for very high tensions; this occurred to me in October, 1889, in working out a project for transmitting 30,000 h. p. over a distance of 60 miles, and I am not aware that any one had made transformers in this way before that date, nor do I find that the patent No. 428,648 of Professor Thomson bears upon the fact.

As to any similarity between the forms of the transformers, the only published drawing that I have seen—that contained in the United States patent—is not clear enough to distinguish the arrangement, but I may state that transformers of the type shown in THE ELECTRICAL ENGINEER, No. 153, were constructed in the Oerlikon Works in November, 1889, and put to work in an installation in the beginning of 1890.

C. E. L. BROWN.

OERLIKON BEI ZURICH,
April 25, 1891.

Literature.

National Electric Light Association Twelfth Convention. August, 1890. New York. *Bartlett & Co.* 1891. Illus., 595 pp.

THIS handsome volume contains the full report of the proceedings of the National Electric Light Association, at Cape May, August, 1890. The papers presented at that time were numerous and valuable, and thoroughly deserving of preservation in this form. The volume is the best as to typography and binding issued by the Association and does great credit to the printers.

Universal Wiring Computer for Determining the Size of Wires for Incandescent Lamp Leads and for Distribution in General. By Carl Hering. New York, 1891. *W. J. Johnston Co., Ltd.* 44 pp. 5 x 8 in. Price, $1.

IN this work Mr. Hering has sought to make the labor of calculating the size of wires for electrical distribution as simple as possible and has availed himself of the graphic method for this purpose. The charts contained in the book cover a very wide range of conditions and will be found a useful aid to the electrical engineer. To the charts is added a series of wiring formulæ, and a clear explanation of the manner in which the formulæ are deduced, so that they may be used with intelligence. Tables of wire gauges, weights, resistances, etc., follow the charts, and a number of handy tables are added, by which the size of wire for a given number of lamps, under varying conditions, can be read off directly. The work is gotten up with the usual care exhibited by Mr. Hering, and will, no doubt, enjoy deserved popularity.

HANDY RULES FOR WHIST.

The Employer's Liability Assurance Corporation, Ltd., through Endicott & Macomber, Boston, Mass., have issued a tiny little folder containing ryhmed rules for whist. It will slip easily into the vest pocket or card case, and presents in a pithy poetical form, the principal points which will win at whist.

College Notes.

UNIVERSITY OF PENNSYLVANIA.

The Trustees of the University of Pennsylvania have decided to light the buildings throughout by electricity.

The electric lighting will be partly on the alternating and partly on the direct current system. Two 500-light 1000 volts, alternating and four 500-light direct current dynamos are to be employed. As with the boilers and engines, it is proposed to use several types of American machines. The two alternating dynamos will be connected to a separate switch-board, and so arranged as to run either singly or in parallel, or one may be run as a motor. The direct current machines will be compounded, but so arranged that by throwing a switch they become shunt machines. These will also be so connected to their switch-board as to run separately or in multiple. One alternating, and one direct, machine will be connected by belt to each of the compound engines; the remaining dynamos will be driven each by its separate engine. By this arrangement either dynamo or either engine may at any time of the day be used for experiment or instruction, as is the case with the boilers. This plant, in addition to the machines already belonging to the Department, and including the motors for driving fans, will be larger and more comprehensive than that of any other institution in the country. Students will have actual practice in the handling of the entire apparatus, and will be enabled to obtain a very considerable familiarity with the details and peculiarities of the systems of the principal American manufacturers.

The feeder wires, both alternating and direct current, will be carried underground. The arrangement of the lamps in the buildings will be made by the architects, Wilson Bros., who have also drawn the plans for the entire plant. The plant, when completed, will be under the immediate charge of a superintendent, to whom the officers of the department act as advising and consulting engineers.

It is believed, when the above plans are carried out, that the University of Pennsylvania, as regards its Mechanical and Electrical Engineering, will take the front rank among educational institutions in the completeness of equipment, and facilities for instruction, in those branches.

ROSE POLYTECHNIC INSTITUTE.

The Rose Polytechnic Institute, an advertisement of which appears in the present issue of THE ELECTRICAL ENGINEER, is one of three or four schools in the U. S. which are especially devoted to the education of Civil and Mechanical Engineers. One of the peculiar features of the Institute is the thorough and extensive "shop practice" of the students in Mechanical Engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over forty thousand dollars. H. T. Eddy, the new president, is well known as the Dean of the Faculty of the University of Cincinnati, and a great educator and organizer.

Society and Club Notes.

ELECTRICAL DEPARTMENT, BROOKLYN INSTITUTE.

At the last meeting of this section the following officers were elected: President, James Hamblet; first vice-president, Prof. S. Sheldon; second vice-president, W. D. Sargent; treasurer, R. W. Bayles; secretary, R. J. Murphy. Mr. Hamblet, thanking the members for his re-election as president, read his annual report, which showed the department to be active and vigorous, and one of the largest in the Institute.

Obituary.

WILLIAM J. CULL.

The death occurred recently of Mr. W. J. Cull, the superintendent of fire alarm telegraphs of the City of Albany. He was an old telegrapher, being at one time associated with the Hon. James D. Reid. He had filled the position named since 1875. His nephew, W. H. Cull, is electrical superintendent of the Albany City Railway.

Reports of Companies.

MEETING OF THE WESTINGHOUSE ELECTRIC & MFG. CO.

(*Special Despatch to* The Electrical Engineer.)

Pittsburgh, Pa., May 18, 1891.

The adjourned annual meeting of the stockholders of the Westinghouse Electric and Manufacturing Co. was held in this city this morning, in the Westinghouse building. There was not a very large attendance of the stockholders, probably for the reason that the result of the meeting had been anticipated by most of them. Mr. Geo. Westinghouse, Jr., president of the company, called the meeting to order and then requested that a motion to adjourn the meeting again for two weeks be offered. Mr. Westinghouse explained this suggestion by stating that the majority of the stockholders had hardly had the time to send their certificates of stock to the Mercantile Trust Co. of New York, and as it would be necessary to have the majority assent to the proposed plan of reorganization it would be better to wait until June 1. This suggestion was accepted, and the motion was passed unanimously.

After the meeting, Mr. Westinghouse stated, that so far he had not heard of a single opposing voice to the plan and he felt confident that everything would be settled satisfactorily within a few days. He urged the stockholders to send their shares of the stock in as soon as possible, in order to delay the matter no more than was absolutely necessary.

BELL TELEPHONE OUTPUT.

The instrument output of the Bell Telephone Company for the month ended April 20 and for the four months of the company's fiscal year is reported in comparison with last year, as below:

Month ended April 20.	1891.	1890.	Inc.
Gross	6,418	6,062	351
Returned	3,278	1,892	1,386
Net	3,135	4,170	*1,035
Since Dec. 21—	1891.	1890.	Inc.
Gross	22,367	18,881	3,486
Returned	12,839	8,042	4,797
Net	9,528	10,839	*1,311

*Decrease.

DIVIDENDS.

The Erie Telegraph and Telephone Company.—A quarterly dividend of one per cent. will be paid by check mailed to stockholders May 18th, that were of record at noon, Wednesday, May 6th. The Cleveland Telephone Company, the Northwestern Telephone Exchange Company, and the Southwestern Telegraph and Telephone Company, report for the three months ending March 31st, 1891, a

Gross income of	$202,398.65
Gross expense (including dividends paid)	199,186.27
Surplus	$3,297.38
SUBSCRIBERS.	
Number connected December, 1890	13,147
Added during the quarter	229
Total number connected March 31st, 1891	13,376
Proportion of dividends received by the Erie Telegraph and Telephone Company	$53,156.37
Dividend No. 30	48,000.00
Surplus	$5,156.37

Fort Wayne Electric Co.—The directors of the Fort Wayne Electric Company have declared a dividend of 75 cents per share, payable May 15, to stockholders of record May 9.

Skowhegan, Me.—The directors of the Skowhegan Electric Light Company have declared a semi-annual dividend of 3 per cent. upon the stock of the company, payable June 1st.

STOCKS AND BONDS.

Springfield, Mass.—At a recent meeting of the United Electric Light Company, it was voted to increase the capital stock from $300,000 to $400,000, and half of the new certificates will be issued June 10. The balance will be issued September 1.

The stockholders of the Southern New England Telephone Co. have ratified the action of the directors in bonding the company to the amount of $300,000 to secure its indebtedness.

ELECTIONS.

Attleboro, Mass.—At a meeting of the North Attleboro Steam and Electric Co., choice was made of the following board of directors: E. S. Horton, Geo. Demarest, L. W. Dillon, Peter Nerney and H. M. Daggett, Jr. Subsequently the directors organized by the election of Peter Nerney, president; C. T. Guild, treasurer, and P. E. Brady, clerk. The company is prosperous, every horse-power of its motor service being in use to-day and an increased demand for its arc and incandescent service presenting itself. Twenty arc lights, of the 52 thrown up by the town's foolishness, go into service in a single jewelry factory.

Putnam, Conn.—The Putnam Light and Power Company has elected the following officers: President, the Hon. J. B. Tatem; secretary and treasurer, A. W. Bowen; directors, J. B. Tatem, J. W. Manning, Orrin Morse, Dr. O. La Rue, S. H. Seward.

Utica, N. Y.—At the annual meeting of the Baxter Overland Telephone Company, all of the officers were re-elected, with the exception of Director Max Lehmann, who has removed to New York. Louis Friede was elected to fill the vacrncy.

New Haven, Conn.—At the annual election of the Southern New England Telephone Co. the following directors were re-elected: Morris F. Tyler, Lyman B. Jewell. A. Heaton Robertson, William E. Downes, A. W. Jillson, James English, A. O. Morgan, Samuel E. Merwin, Thomas Sherwin.

Detroit, Mich.—The Brush Electric Light Co., of Detroit, held its annual meeting May 12, 1891. $600,000 capital. Running 1,800 h. p. and doing well. Officers elected: Wells W. Leggett, president; Wm. C. Colburn, vice-president; Jas. L. Edson, treasurer: H. Leonard Wilton, secretary and general manager.

Appointments, Etc.

Mr. C. D. Paige has resigned as treasurer of the Stockbridge, Mass., Gas and Electric Company, and is succeeded by C. W. Johnson, and the office will remain where it has been. A. McLean, who has been in the service of the company for the past year, has been appointed general manager and superintendent of the plant and will have charge of all the practical part of the business. The Southbridge Gas and Electric Company is on a dividend paying basis, and is as well established a concern of the kind as there is in the state.

Mr. C. B. Martin, has been appointed manager of the telephone exchange of Binghamton, N. Y.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of May 16, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80¼	Edison Gen. Elec. Co	101
American Tele. & Cable	80¼	Edison Gen. Co. Pef'd	....
Centl. & So. Amer	145	Consol'd Elec. Lt. Co	...
Mexican	205	Edison Illu'g Co. N. Y	76
Com. Cable Co	105	U. S. Elec. Lt. Co	80
Postal Tel. Cable	39	North Am. Phonograph	. ..

BOSTON.

	BID.		BID.
Thomson-Houston	44¼	Ft. Wayne Co	12
" Pref'd	25¼	Am. Bell	208
" Series C	....	Erie	48
" " D	7	New England	....
" Int. Co	....	Mexican	.90
Thomson Welding Co	....	Trop. American	.60
Thomson Eu. Welding	55	Edison Phon'gph Doll	.50
Detroit Electrical Works	12¼		

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	161¼
Ches. & Pot. Telephone	60¼	Eck.&Sold. Home Elec. Ry.	48
Amer. Graphophone	5⅞		59¼

*Ex. Dividend.

PITTSBURGH.

Westinghouse El. Man. Co	15

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 12, 1891.

Accumulators :—

Secondary Battery, J. Emmner, Jr., 451,921. Filed July 9, 1889.

Consists in making either or both of the elements of aluminum and using any suitable active material.

Alarms and Signals :—

Electrical Signaling Device, C. J. Kintner, 452,026. Filed July 15, 1890.

A central station signaling system adapted for use in connection with the automatic individual signaling apparatus patented by Adin A. Hatch, Sept. 2, 1890, No. 435,983.

Visual Indicator for Fire Alarm and Other Purposes, M. G. Crane and F. W. Cole, 452,165. Filed March 7, 1890.

Relates particularly to visual signals to be displayed in sight of firemen or others whose attention is required.

Bell Striker, M. G. Crane, 452,166. Filed Nov. 17, 1890.

Employs electro-magnetic apparatus for controlling a bell striker actuated by other power.

Clocks :—

Clock Synchronizer, A. G. Wiseman, 452,239. Filed Dec. 17, 1890.

Synchronizing mechanism actuated by an electro-magnet, the armature of which is attached to a lever pivoted in a plane which is at the side of the centre of the face of the magnet and has a compound movement.

Conductors, Conduits and Insulators :—

Coupling for Electric Wires, A. M. Hunt, 451,933. Filed Dec. 29, 1890.

A metal sleeve having an internal diameter not less than the combined diameters of the wires to be joined and adapted by twisting to bind the enclosed wires together and to conform to their external surfaces.

Conduit for Electric Wires, T. T. LaPoint, J. H. Flanagan and C. A. Thompson, 451,941. Filed Dec. 30, 1889.

Conduit is composed of a cylinder of sheet metal firmly rivetted at the seam and dipped in a composition of asphalt, resin and fatty matters, an internal lining of hydraulic cement and an external wrapping of layers of tarred paper alternated with layers of a composition of asphalt, resin and fatty matter, and over all a layer of the asphalt composition.

Electric Insulator, S. Oakman, 451,950. Filed Aug. 17, 1889.

An insulator of the usual form of glass insulator but with the addition of a member forming an eye upon one side to receive a line wire.

Machine for Covering Electrical Conductors with Lead, L. W. Tracy, 451,960. Filed Aug. 4, 1890.

The pipe-forming chamber is constructed in a narrow trough shape with upwardly-flaring sides and ends and a bottom curved concentrically with the die and core bar projecting across its shorter axis.

Process of Treating Conductors, J. B. Williams, 452,091. Filed July 11, 1890

The conductor is surrounded by a dielectric arranged with intermediate air spaces; the dielectric is raised to a suitable temperature when warm dry air is passed through the air spaces, the air being kept under pressure in the air spaces.

Wire Clamp, R. M. Jones, 452,185. Filed Dec. 17, 1890.

For linemen's use.

Electric Cable, W. A. Conner, 452,340. Filed July 24, 1890.

Wires are covered with saturated fibrous material arranged to form an open mesh providing air spaces.

Electric Cable, W. A. Conner, 452,341. Filed July 24, 1890.

Designed to prevent the spreading of moisture that may enter the cable at any point. The wrapping surrounding the insulated wires is omitted at definite intervals along the length of the cable; a sealing material is applied to impregnate and fill the core at the points of omission of the wrapping; the lead sheath is closely compressed round the core where it is impregnated with the sealing material.

Electric Cable, W. A. Conner, 452,342. Filed July 24, 1890.

Similar to No. 452,341 above.

Dynamos and Motors :—

Brush Holder, H. H. Blades, 451,909. Filed Aug. 14, 1890.

Designed to permit the position of the holder with respect to the commutator to be reversed without removing any of the parts from the supporting shaft or spindle.

Self-Controlled Motor Switch, G. H. Whittingham, 452,151. Filed April 25, 1890.

For simultaneously closing or opening communication between the main or working circuit and two branch circuits, the one including the field and the other the armature of the motor.

Electric Motor, D. J. Chisholm, 452,214. Filed Sept. 27, 1890.

A motor of the type employing a series of stationary magnets around its periphery and a system of revolving magnets within.

Electric Reciprocating Engine, C. J. Van Depoele, 452,296. Filed June 26, 1889.

A continuous current motor. Consists of two working circuits, a reciprocating motor having two coils, one in each working circuit, a magnetic piston, means for simultaneously increasing the current in one coil and decreasing it in the other.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, G. C. McCullough, 451,948. Filed Sept. 3, 1890.

Has a double set of elements so arranged that one set may be used while the other is permitted to rest,

Primary Battery, W. Hanson, 452,303. Filed Feb. 4, 1891.

Relates to means for supporting the porous cell and electrodes upon a wooden frame at the top of the jar.

Lamps and Appurtenances :—

Drop for Electric Lamps, W. E. Dow, 451,996. Filed March 22, 1890.

An adjustable hanger.

Holder for Portable Electric Lamps, W. W. Savage, 452,288. Filed Feb. 20 1891.

When in the holder the weight of the lamp keeps the circuit open. Its removal closes the circuit.

Incandescent Electric Lamp, W. M. B. Keen & W. F. Haarmann, 452,305. Filed June 19, 1890.

Relates to the mechanical construction of the switch and socket.

Incandescent Lamp Socket, W. M. B. Keen, 452,306. Filed Sept 15, 1890.

Details of socket and switch.

Measurement :—

Electric Meter, H. W. Miller, 452,276. Filed Nov. 21, 1890.

Patented in Great Britain, Oct. 29, 1890, No. 17,327. A clock-work meter with differential gear actuating the register and controlled by a coil through which the current to be measured, or a part of it, flows.

Electrical Measuring Instrument, E. Weston, 452,326. Filed July 8, 1890.

A potential instrument. Consists of a coil rotary on its diametrical axis in the field of force of a magnet and disposed between the poles of the latter; the frame supporting the electro-magnets, their cores and the pole-pieces constitute a single magnetic structure.

Medical and Surgical :—

Surgical Electrode, J. H. Gunning, 452,230. Filed Nov. 20, 1890.

A bi-polar electrode, forming component parts of the instrument itself, and adjustable to vary their distances apart.

Electric Belt, C. D. Williams, 452,250. Filed Jan. 17, 1891.

A belt containing a series of galvanic cells.

Metal Working :—

Electric Rivetting Apparatus, E. E. Ries, 452,042. Filed June 25, 1889.

Details of apparatus for practicing the invention shown in the same inventor's patent of May 14, 1889, No. 403,374.

Miscellaneous :—

Fusible Cut-Out for Electric Connections, W. E. Dow, 451,997. Filed Dec. 4, 1890.

Especially applicable to electric lamps suspended from a drop capable of being raised and lowered.

Electro-Magnet, C. E. Lipe, 452,008. Filed Nov. 20, 1889.

Uses wires of rectangular sections to save space.

Apparatus for Heating by Electricity, C. Zipernowsky, 452,056. Filed Sept. 16, 1890.

Two conducting bodies are so arranged relatively to each other that an imperfect contact of high resistance shall exist between them.

Coin Operated Machine, W. H. Ashwell, 452,068. Filed Nov. 12, 1890.

Employs electro-magnetic releasing mechanism.

Thermal Cut-Out, G. H. Whittingham, 452,152. Filed Oct. 18, 1890.

Details of a fuse cut-out.

Combined Coupling and Cut-Out, J. D. F. Andrews, 452,173. Filed Oct. 27 1890.

Patented in Great Britain Dec. 18, 1889, No. 20,387. Combines a switch and fusible cut-out.

Gas-Engine Attachment, M. M. Barrett, 452,174. Filed Jan. 7, 1891.

An electric ignition device for the combustion chamber.

Railways and Appliances :—

Motor Truck, F. M. Lechner, 451,942. Filed July 23, 1890.

A motor truck for mining machines. Tool operating mechanism is mounted on the truck together with the motor.

Electrically Propelled Car, S. H. Short, 451,980. Filed Nov. 6, 1890.

Claim 1 follows:

The combination, with a car, of an electric propelling-motor comprising an armature mounted on and directly secured to a car axle, and non-rotative field magnets mounted on springs independently of the said armature.

Mounting for Electric Car Motors, S. H. Short, 451,981. Filed Dec. 1, 1890.

Armature is mounted directly upon the car axle; field magnets are directly journaled on the axle; a connection with side bars connects the pedestals and journals boxes of the two car axles.

Electric Railway Signal, W. C. Walter (deceased, S. L. Walter, Executrix), 451,999. Filed Nov. 23, 1889.

For intercommunication between vehicles or trains operated on the block system.

Driving Mechanism for Electric Motor Cars, S. H. Short, 452,005. Filed Nov. 1, 1890.

Employs a ring armature mounted axially upon a driving axle and non-rotative multipolar field magnets, the pole pieces of which are arranged to produce a field of force crossing the armature parallel to its plane.

Motor Car for Electric Railways, S. H. Short, 452,035. Filed Nov. 26, 1890.

Armature mounted directly on a driving axle; the field magnets are directly journaled on the same axle and a connection is made with another car-axle which holds the field-magnets from rotating.

Machinery for Propelling Electric Cars, S. H. Short, 452,036. Filed Dec. 9, 1890.

A single reduction system.

Electric Wire Suspender, C. A. Lieb, 452,017. Filed Nov. 8, 1890.

A trolley wire suspender.

Method of Braking Trains, E. E. Ries, 452,041. Filed Oct. 4, 1888.

Supplements the mechanical brake by increasing the friction between the wheels and rails by the passage of electric current.

Automatic Railway Signaling Apparatus, S. J. Doucet, 452,072. Filed Oct. 22, 1890.

Employs one electrically continuous rail and one having insulated sections. Alarm on board a train is put in circuit by contact brushes carried on the car.

Electric Railway, M. W. Dewey, 452,099. Filed Dec. 20, 1890.

Combines an induction and a conducting system. The induction system intended to be used on those parts of roads running through cities where trolley wires are impracticable. The invention consists broadly in an electrical railway having a portion equipped with a conduction system and another portion equipped with an induction system.

Electric Railway, F. O. Blackwell, 452,160. Filed Nov. 23, 1888.

Relates to an underground conduit system, and consists mainly in details of construction for the conduit and conductors.

Electric Car Motor, J. Christiansen, 452,176. Filed May 21, 1890.

Relates to the mounting of motors upon electric locomotives and to their connection with the driving axles.

Trolley Stand, R. M. Jones, 452,186. Filed Dec. 29, 1890.

A spring trolley stand with a revolving or oscillating base.

Railway Signaling Device, J. C. O'Neil, 452,281. Filed June 30, 1890.

For road crossings and similar service.

Telegraphs :—

Printing Telegraph, E. Pope, 451,951. Filed Feb. 18, 1888.

Receiver operates after the manner of a typewriter.

Telephones and Apparatus :—

Automatic Toll-Box, I. H. Farnham, 451,922. Filed Feb. 13, 1891.

A nickle-in-the-slot telephone call box.

TRADE NOTES AND NOVELTIES

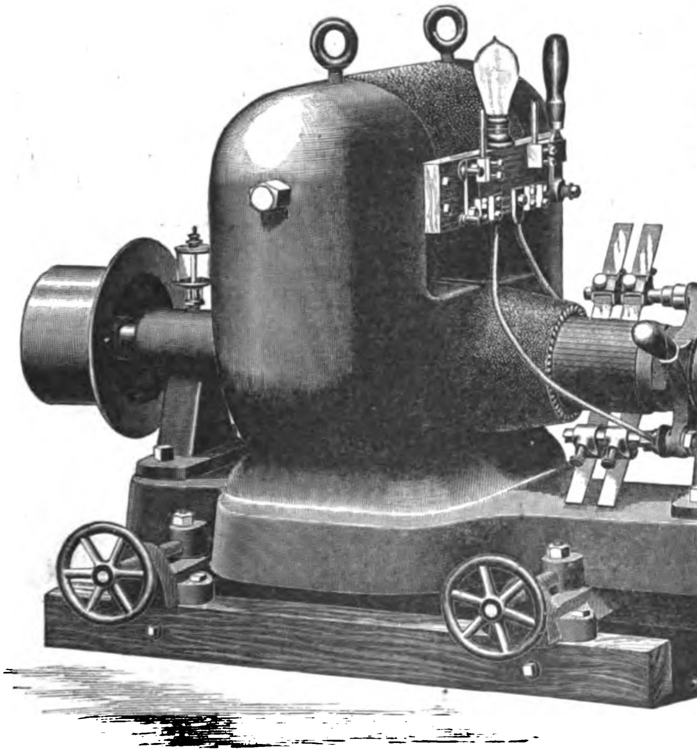
AND MECHANICAL DEPARTMENT.

Advertising is always interpreted as a sign of life, activity and progress. Dead men don't advertise.

THE HOWARD DYNAMO.

It will be readily conceded that a good dynamo, which may be had at a reasonable price, one with a high electrical efficiency that will cost little for repairs, and will regulate well, built with all the parts interchangeable, so that the armature, field magnet, commutators, etc., may, in case of necessity, be replaced with promptness and at the lowest possible cost, leaves but little to be desired.

The Howard dynamo, shown in the accompanying illustration, is claimed to possess all these advantages. The field magnet has but one magnetic circuit of low resistance, and but one coil, having both shunt and series windings, magnetizes the field. The pole pieces consist of massive castings of charcoal iron. The armature is of the drum type, and is wound with flat bars of copper, in order that, while keeping the distance as short as possible between the pole pieces and the core, the number of turns and the cross section of the copper shall be sufficiently great. The armature of a 300 light machine has 80 turns, with a resistance of .02 ohm, while the resistances of the shunt and series coils of the field are 19 ohms and .008 ohm, respectively.



The Howard Dynamo.

These machines are manufactured by Messrs. Hiram M. Howard & Co., of Cincinnati, O., and are built in twelve sizes, ranging in capacity from 10 to 500 lights. As motors they are wound for 110, 220, and 500 volt circuits, and develop from ⅛ to 35 h. p. Both motors and dynamos have been installed in various parts of the country, and are proving highly satisfactory in operation.

THE WIGHTMAN ELECTRIC MANUFACTURING COMPANY.

The above company, of Scranton, Pa., report to us that the recent fire in that city, in which the People's Street Railway Car house was destroyed, did not in any way damage them. On the contrary, it caused the People's Company to place with them an order for ten complete double-motor (new S. R. Motor) car equipments, all of their own manufacture. This, together with the six double-motor equipments to go to Easton, Pa., (all of these equipments to be delivered within the next sixty days), makes them very busy. Their factory is now running day and night. They now have orders booked for thirty five complete car equipments, and the prospects for a large and flourishing business are very favorable.

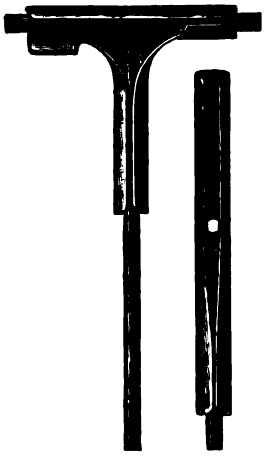
In the fire in the People's Car house, thirty-three cars—twenty five of which were equipped with double-motors—were totally destroyed; but thirteen cars, which, at the time of the fire, were standing on sidings outside the car house, were saved from the flames; the car house was reduced to ashes. The thirteen cars that escaped the flames, together with two cars fitted up with the two motors which the Wightman Co. have lent them, gives the People's Company fifteen serviceable cars; so that the system is by no means entirely crippled. The cars and car house were insured for $125,000, and that amount will nearly cover the damages.

DR. ARON'S ELECTRIC COUNTERS.

The representative of Dr. Aron in this country, Mr. F. Hackenthal, of No. 21 Beekman street, this city, has decided to temporarily close his office in this country. This, however, will not interfere with the delivery of the well-known Aron meters to the trade. All inquiries may hereafter be addressed to Prof. Dr. Aron, Lutzow Str., 6, Berlin, W., Germany.

BURT AND TOBEY'S ELECTRIC WIRE COUPLING.

The convenience of application of these couplings, which are shown in the accompanying illustration, especially adapt them to the use of wiremen, as they require for their adjustment only a pair of ordinary bell hanger's pliers. They make a perfect electrical, and a very strong mechanical, connection, and are so simple that they can be very cheaply made.



Burt & Tobey's Wire Coupling.

These couplings are made of both brass and copper, tinned for convenience of soldering, and do not materially increase the size of the wire. The sole agency is held by the Rhode Island Telephone and Electric Co., 13 Mason St., Providence, R. I.

SOUTHERN ELECTRIC CO.

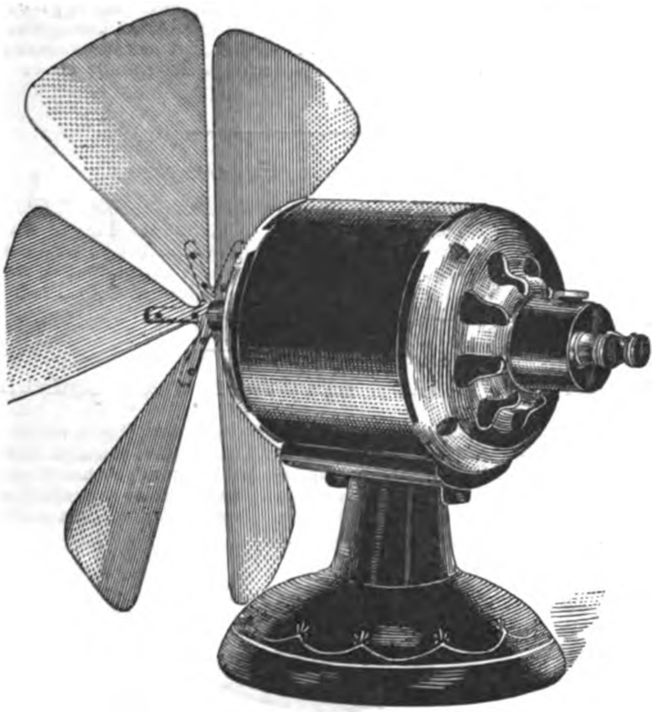
Under the personal management of Mr. J. F. Morrison, the Southern Electric Company, of Baltimore, is doing an increasingly thriving business. Mr. Morrison has taken hold of a number of new specialties and will push them on the market with his well-known vigor. Baltimore is a most excellent distributing point for electrical supplies and one that has thus far been almost neglected. This is changed now and it will no longer be necessary for our Southern friends to send to New York, Boston and elsewhere for supplies, which are now being carried in stock by the Southern Electric Company.

ENGINEERING EQUIPMENT CO.

Since removing to their new quarters in the Central Building, 143 Liberty street, the above company have issued two handsome, colored circulars, one relating to the Habirshaw wires, cables, etc., and the other to the indurated fibre pipe for electric conduits. The Habirshaw folder gives a complete list of prices, etc.

THE WAGNER ALTERNATING CURRENT MOTOR.

Owing to the great number of electric lighting stations now using the alternating current, a great demand has arisen for alternating current motors of small power, for driving fans, sewing machines, dental lathes, etc. A novel little motor for this purpose, has recently been brought out by the Wagner Electric Manufacturing Co., of St. Louis. As will be seen from the accompanying engraving, this motor is exceedingly compact and substantial in construction. The field is of the form known as iron clad, and admits of the shortest possible magnetic circuit, and the brass end pieces carrying the bearings and brushes are designed to protect the armature, commutator and brushes as much as possible, but are readily removed when necessary. The armature and commutator are built so as to practically eliminate sparking, and the brushes, which are of carbon and self-feeding, need no attention or adjustment, and require replacing but once in two months if used continuously. To renew the brushes it is simply necessary to remove the screw caps serving as binding screws, when the brushes and springs readily drop out. The bearings are self-oiling, and require no more attention than the brushes.



Wagner Alternating Current Motor.

The motor shown is rated at $\frac{1}{10}$ h. p., and runs a six bladed 10 inch fan with a pitch of 80° to 85°, 2,000 revolutions per minute, with an expenditure of 100 watts of electrical energy. The heating of the armature and fields is less than in most direct current motors, the rise in temperature never exceeding 20° C., above the surrounding atmosphere. These motors can be furnished of $\frac{1}{10}$, $\frac{1}{4}$, and $\frac{1}{2}$ h. p., for pressures from 50 to 110 volts for either alternating or direct currents, and furnished with fan or properly mounted for sewing machine or dental work. Patterns are now being made for a 1 h. p. motor which will run at constant speed with any load up to its rated capacity. This larger sized motor will be admirably adapted for pumping church organs, running small elevators, and a large variety of power work.

SHORT ELECTRIC RAILWAY CO.

The Short Electric Railway Company is putting a strong and energetic force of salesmen into the field for the purpose of covering territory to an extent that they have not yet done. They are securing some of the best trained railway agents in the business, and within a very short time the company expects "to be in at the death" on every street railway contract.

PERFORATING A BELT.

Chas. A. Schieren & Co. recently gave the Owensboro, Ky., Electric Light Co. the privilege of perforating a belt that gave them considerable trouble. Under date of May 8, the Owensboro people wrote as follows to the firm: "We have perforated the belt and are more than pleased with it; we used to have to run it so tight it was very near impossible to keep the journals cool; it now runs very slack and without waving or flopping. When we want more belts shall certainly use your perforated."

THE EDISON PHOTOPHONOKINETOGRAPH.

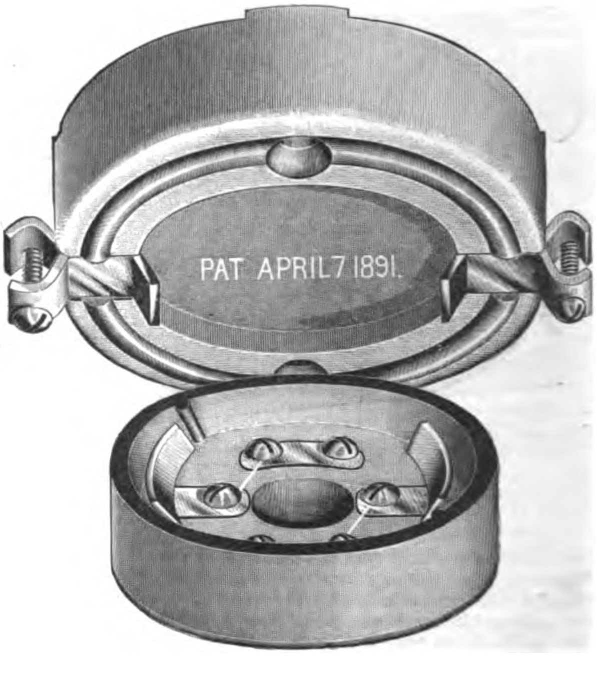
A dispatch from Chicago May 12, says: Thomas A. Edison was asked to-day if had an electric novelty in store for the Columbian Exposition. He said:

"Well, I have a thing in view, but the details are yet somewhat hazy. My intention is to have such a happy combination of photography and electricity that a man can sit in his own parlor and see depicted upon a curtain the forms of the players in opera upon a distant stage and to hear the voices of the singers. When the system is perfected, which will be in time for the fair, each little muscle of the singer's face will be seen to work, every color of his or her attire will be exactly reproduced, and the stride and positions will be as natural as those of the live characters. To the sporting fraternity I will state that ere long this system can be applied to prize fights. The whole scene, with the noise of the blows, talk, etc., will be truthfully transferred. Arrangements can be made to send views of the mill *a la* stock and race ticker."

Speaking of this the other day in Brooklyn, Mr. Edison said: "I make forty-six photographs a second on a moving sheet and by exhibiting this sheet moving at the same speed the scene is reproduced. I had a man sing into a phonograph the other day and I photographed him by this process as he was singing. Then I gave a concert. The phonograph reproduced the singing and the kinetograph reproduced all his motions and gesticulations."

NEW PERKINS CUT-OUT.

We illustrate in the accompanying engraving a new form of ceiling cut-out, which possesses some novel features. The base of the cut-out is made of porcelain with only two brass pieces attached to it, to form the binding posts for the main wires and the contacts for the cap. The cap is also made of porcelain, and has two brass lugs connected through fuse wires to the terminals of the lamp cord, which dovetail underneath the contact pieces on the base, when in position. The action is extremely simple, as there are no screws to be tightened when putting in place, the cap being held in the groove, and by a slight turn of the hand the contact is completed, the dovetails making a perfect rubbing electrical contact. The cut-outs are manufactured solely by the Perkins Electric Switch Company, of Hartford.


PAT APRIL 7 1891.

The Perkins Ceiling Cut-Out.

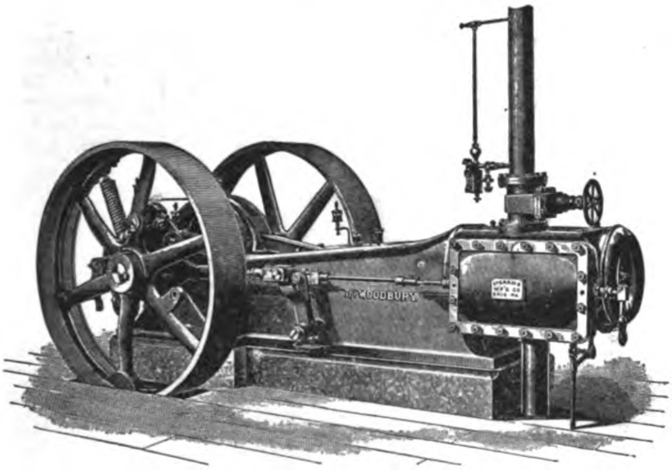
POSTAL TELEGRAPH CO. IN SAN FRANCISCO.

The growth of the business of this enterprising company has necessitated the removal of its San Francisco headquarters to the commodious new building at 582–586 Market street. This new building is one of the ornaments of the city; it is of granite and brick, with steel beams and copper roof, and is claimed to be thoroughly fireproof. The furniture is of antique oak, and the operating tables are of black walnut. No expense has been spared to make it perfect in all details.

THE WOODBURY HIGH-SPEED STEAM ENGINE.

We illustrate in the accompanying engraving the latest type of the Woodbury engine, designed by Mr. Daniel A. Woodbury, of Rochester, N. Y., and built by the Stearns Manufacturing Co., of Erie, Pa,

In cross section the frame is a tapering box, wide at the base, and heavily flanged at the top and bottom, the top flanges extending from the hood formed at the cylinder end, in a direct line to main bearings. At the crank end, the frame widens out to afford an unyielding support to the journals, and the top flanges also become wider towards the boxes, the latter being cast with the frame.



The Woodbury Automatic Engine.

The governor is of that class in which the valve closure is effected by moving the eccentric across the shaft. The movement of the eccentric is operated by centrifugal weights, the centripetal force being furnished by a single spiral spring. The direction of the pull of the spring is such as to bring the bearings upon the pivot pins always on the same side, whether the weights be moving outward or inward, thus avoiding all lost motion and rattling due to either wear or loose fitting.

The valve employed is of the adjustable type and balanced by means of a relief plate, thus taking the steam pressure off the valve and eliminating all valve friction. This leaves the governor free to act upon the valve and to change the lead with change of load in the shortest possible time.

The shaft and crank pin are formed with the cranks in one solid steel forging, and the construction is such that the counterbalancing discs can be readily removed and replaced in their original position; this allows of easy access to the pin which can then be trued up in a lathe, when necessary.

The relative weight of counterbalance to that of the reciprocating parts has been determined by a series of experiments throughout the entire range of speed, and with changeable counterweights. The proportions adopted are such as to secure perfect smoothness of action and an entire absence of vibration under the different conditions of load, speed, and steam pressure. The engines are tested for this quality by loosening the foundation nuts, and running up to speed, with the belt off. With the proper amount of counterbalance, no vibration or tendency to longitudinal movement is shown, the engine running as steadily as when bolted down.

The lubrication of all the moving parts has been thoroughly provided for, and the best materials and workmanship employed in the construction of these engines, which have already been introduced in a large number of electric light stations.

THE LLOYD AND PAXTON STORAGE BATTERY.

Electric railway managers, while expressing a preference for a car which will be self-propelling, have heretofore looked with suspicion on storage battery traction on account of the great cost of the batteries and their comparatively short life. In seeking to overcome this difficulty and also to provide a cell which shall have a high rate of discharge, Lloyd & Paxton, Ltd., of 2 Wall street, this city, are now ready to supply a cell which shall fulfill all the requirements, not only of street car service, but which is also eminently adapted for electric lighting. The grids of these cells are made of pure lead without the slighest imperfection. A large number of perforations are used, all containing exactly the same quantity of active material, and the plugs are firmly held in place by the concave section of the walls of the grid.

Starting out with the object of producing a cell at as low a cost as possible, the company has perfected a machine which makes the lead grids at the rate of 6,000 plates per day, and with the regularity of an envelope machine. On account of the large number of perforations, a large surface contact is established between the grid and the active material, and the even distribution of the metal of the grid results in equal electrical action over its entire surface. This machine is so constructed that it can make plates of any thickness from 1-16 of an inch to ½ inch, thus allowing of any type of cell being made, such, for instance, as a lighting battery with heavy plates.

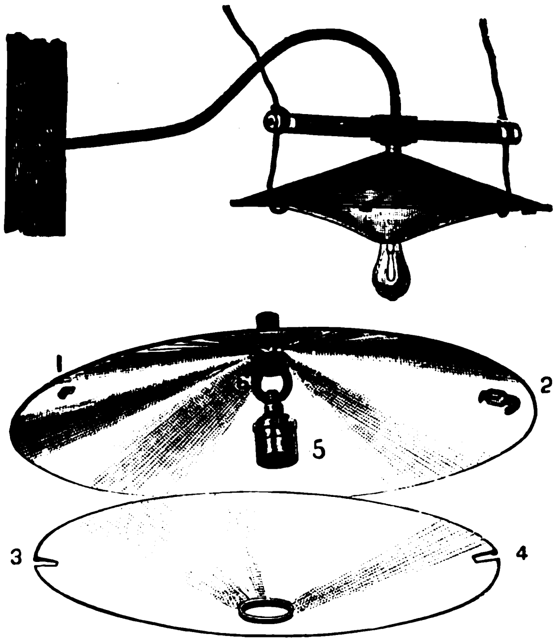
A cell of the railway type having a capacity of 175 ampere hours weighs only 25 pounds, and can be discharged at the rate of 100 amperes for one hour without dropping below 1.9 volt. The normal rate of delivery, however, is 50 amperes. This gives the very high capacity of .8 ounce of active material per ampere hour. This high rate of delivery is evidently a most valuable feature in connection with storage battery traction, as a motor propelling a 16 foot car frequently calls for nearly 150 amperes at starting and in climbing a grade of four per cent. The positive elements are calculated to last six months in railway service, and the negatives fully 18 months. The company propose to sell the cells at $5 a piece, and to buy back the old lead when the cell is practically worn out.

FIREPROOF LAMP CORD.

As the Boards of Underwriters in some states have condemned the use of any lamp cord that is not fireproof, the Central Electric Company, of Chicago, are offering a cord with an absolutely fireproof covering. They have already had large sales of this cord, and predict that before long it will drive all inferior articles out of the market.

THE "CLIPPER" STREET HOOD.

This hood consists of two pieces, the hood seventeen inches in diameter, and the reflector. These parts are seamless and made from spun zinc so as to withstand the influence of the weather. The hood is finished in green and the reflector in white enamel to procure the greatest efficiency in light. The fastenings consist of two hooks, one of them stationary and the other adjustable, and can be worked with one hand. These shades are furnished for either one light or a cluster, and do not require any tools to put them up. They are manufactured by The Illinois Electric Material Co., of Chicago. The cut represents the hood half open so as to show working portions. 1 is the hook; 2 the sliding hook; 3 and 4 the clip; 5 the socket, and 6 the bushing.



The "Clipper" Street Hood.

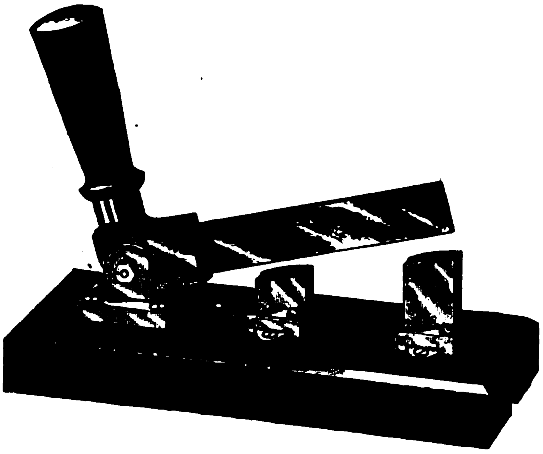
THE BRYAN FARADIC BATTERY.

This battery, which is one of the products of the Bryan Electrical works, of Springfield, Mass., is manufactured exclusively for physicians' use. The case is of walnut and the cell of hard rubber. More than 9,000 of these instruments have been sold to physicians over the United States, and are all giving satisfaction.

THE WIRT KNIFE SWITCH.

We illustrate a pattern of knife switch designed by Chas. Wirt, differing in many respects from the ordinary switches of this class. It is a double break and is so constructed that the knife cannot jar out of position, either closed or open.

No binding posts are used, the connections are made on the back by powerful clamps which are closed with screws from the front. The wires can be secured after the switch has been placed on the wall.

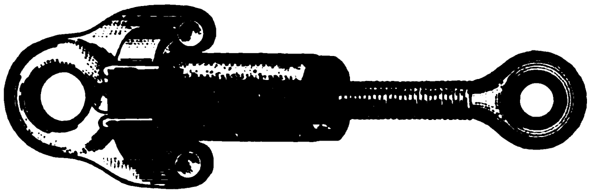


The Wirt Knife Switch.

These switches are made in all sizes, with slate or mahogany bases, by the Electrical Supply Co., 171 Randolph street, Chicago.

A NEW FORM OF MICA INSULATOR FOR SPAN WIRES.

Much difficulty has been experienced by the electric street railway engineer in thoroughly insulating the trolley wire from the poles. It has been found necessary, by experience, in addition to insulating the trolley wire from the span wire, to insulate the span wire from the pole, and we take pleasure in illustrating in the accompanying engraving a new form of mica insulator which has the double advantage of being a combined span insulator and turn buckle for tightening the span wire. The method of using the insulator is as follows: In setting up a span, the wire is cut off to the proper length, and both ends are attached to the eye-bolts of the insulators (two being used for each span), one of the eye-bolts being unscrewed from its case. The end of the span wire attached to the complete insulator is then hung up by means of the eye-bolts to the pole clamps provided, and the other insulator, without the eye-bolt, is hung up on the opposite pole. With an ordinary tackle the span wire is then tightened up until the eye-bolt enters the insulator, and the whole span can then be tightened by screwing up with a wrench. In this way spans can be put up in half the ordinary time, and a thoroughly insulated trolley wire is secured. The strength of these span insulators is sufficient to break a No. 2 B. W. G. span wire without injury to the insulator. They are manufactured exclusively by the Gould & Watson Company, 34 Hartford street, Boston. A number of them have just been put up on the Brooklyn City Electric Railway, Brooklyn, N. Y.



Gould and Watson Mica Span Wire Insulator.

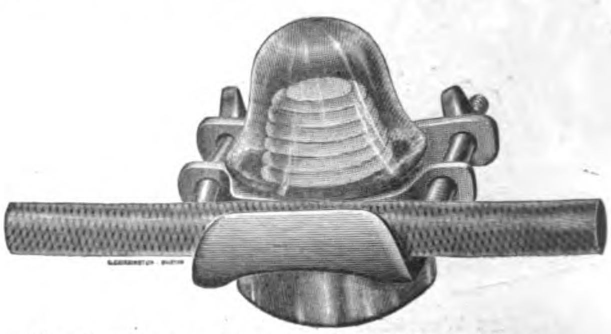
Clay, Pepper & Register have moved into new offices in the Provident Building, Chestnut and Fourth streets, Philadelphia, where they will have more room and better facilities for attending to their consulting and construction business as electrical engineers.

SOUTH LAKEWOOD PARK.

Pine & Maguire, 18 Wall street, who are the agents of the South Lakewood Park Co., in which so many electrical men are interested, have issued a very pretty and tasteful brochure describing and illustrating the property. In view of the enormous success of Lakewood, there seems no good reason why South Lakewood, its suburb, and a place superior in many of its attractions, should not soon enjoy like popularity and prosperity as a Northern Florida.

THE PETTINGELL ANDREWS FEEDER WIRE HOLDER.

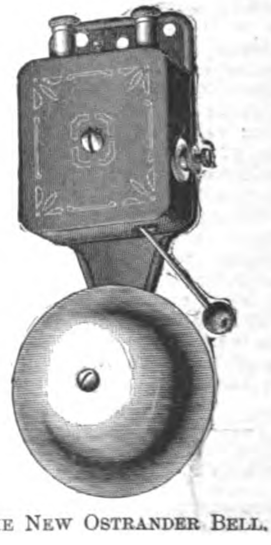
We illustrate this week a novelty in the shape of a new form of feeder wire holder, specially designed to tie large feeder wires to the insulator, as shown, without the necessity of the old tie wire, which takes time and labor, and is extremely apt to damage the insulation. This holder is much cheaper than tie wires, holds the cable or wire in a firm and secure grip, saves labor, time and money, and absolutely prevents any abrasion of the insulation, thereby preventing loss of current. It is manufactured exclusively by the Pettingell Andrews Company, of 196 Summer street, Boston.



The Pettingell Andrews Feeder Wire Holder.

THE OSTRANDER BELL.

The accompanying illustration shows an admirable, new iron box electric bell, manufactured by Messrs. W. R. Ostrander & Co., of 195, 197 Fulton street, this city. The armature has bottom and side adjustments, and is pivoted in such a manner that, although working very freely, it is impossible for the points to get out of contact. The bell can be adjusted to ring on one cell of battery. **The contacts are made of platinum wire, and the armature spring is of phosphor bronze.**



The New Ostrander Bell.

The works are all in the box, held by a centre screw to the back plate which may, therefore, be permanently fastened to the wall.

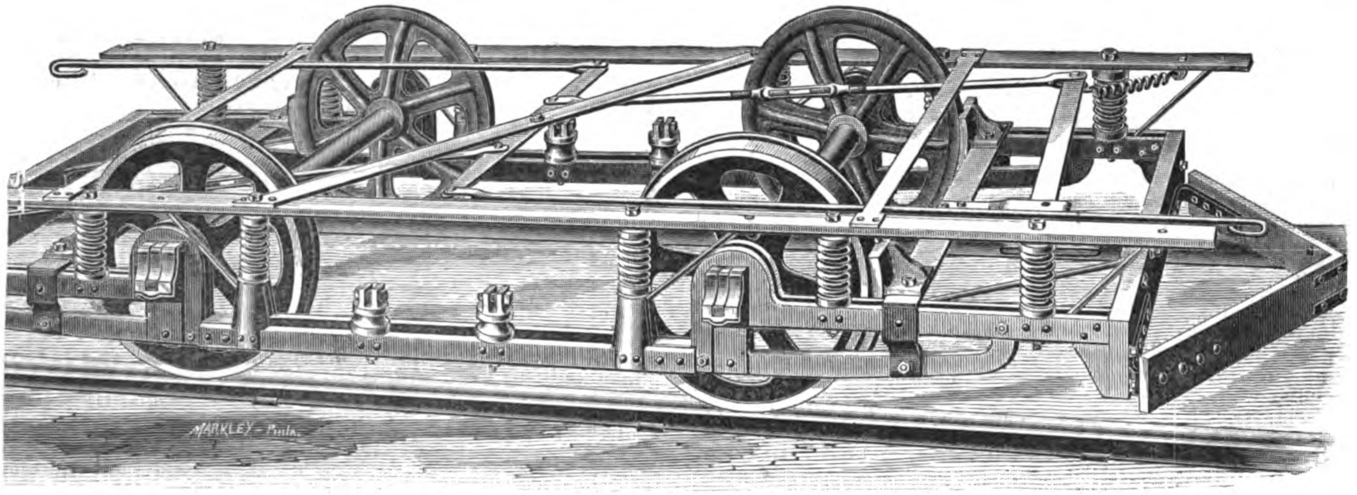
The Thomson Electric Welding Co. is building three large welders for the Johnson Co., at Johnstown, Penn.

MAINE ELECTRIC IMPROVEMENT CO.

Messrs. Alex. Henderson and Thomas J. Fay, late of the Hunt Engineering Co., of Brooklyn, N. Y., have combined their efforts, in connection with Mr. James L. Doolittle, a well-known banker and financier, of Brunswick, Maine. The result is a new and well equipped engineering company, under the name of the Maine Electric Improvement Co., incorporated under the law of the state of Maine, the home office of which is at Brunswick, with Mr. Henderson, as president, and Mr. Doolittle as secretary and treasurer; with general business offices in the Electrical Exchange building, corner Liberty, Washington and Cedar streets, New York city, with Mr. Fay as general manager. This company will make a specialty of furnishing plans, specifications, electrical tests and reports on proposed plants, and will also do a general engineering business, while from time to time they will place at the disposal of the public many new and interesting specialties of their own manufacture.

THE ROBINSON ALL STEEL ELECTRIC TRUCK.

In studying out the problem of the best method of constructing a truck for use on electric cars, whereby oscillation would be reduced to a minimum, the designer of the one shown in the accompanying illustration became convinced that some form other than that of the cast iron yoke and pedestal would have to be adopted. Constant observation and experience, says the *Street Railway Gazette*, taught him that these yokes, riveted to the side frame, in order to support the extreme ends of the car body, must, necessarily, be so heavy that the truck was usually cumbersome, and the rivets, which held the side bars to the yoke, were located in the most vital part of the truck, which latter frequently pounded itself to pieces, the only alternative being the use of a truck so heavy that extra power was really required to run it.


MARKLEY-Phila.

THE ROBINSON ALL-STEEL ELECTRIC TRUCK.

In the truck shown above, made by C. W. Robinson, of Altoona, Pa., the car body is supported at the extreme ends by springs—no less than a dozen of these springs being used in all. The yokes, in which the journal boxes ride, are made of continuous steel bars, braced below the journal box with an equalizing bar, which distributes the weight equally, and the car wheels and axles may be removed and replaced without disturbing the car body or brake mechanism, by simply removing a bolt at each end of the bars.

The brake can be applied from either end, all up to the wheels being gripped simultaneously. The brake bars slide on the rigid side frames and grip the wheels at the same point, regardless of the weight of load; the brake mechanism lies close up against the car body and does not interfere with the motor.

The motor or armature can be easily removed without disturbing the car body or brake mechanism, thus making all the electric parts readily accessible.

The construction is such that the truck is admirably adapted for the new gearless motor as well as for the old style motor.

MR. PAUL W. BOSSART, of The Short Electric Railway Company, is making an active and efficient canvass in street railway circles of the West. He reports the most favorable outlook for the new gearless motor. Everyone is interested in it and speaks in the highest terms of its simplicity, predicting a wonderful future for this new departure of the Short Company. Mr. Bossart is fortunate in representing so strong a company and one whose past reputation for reliability and excellence of work is of the very highest.

THE INTERIOR CONDUIT AND INSULATION CO.

One of the best proofs of the phenomenal success with which the Interior Conduit system is meeting is the number of large and costly buildings that are being erected in which the system is being used. We name a few of the buildings in which the Conduit system has been used throughout, or has been specified for by the architects:

Fair Building, Chicago, Sperry Electric Co., contractors; Henry Crocker, residence, San Francisco, Cal.; Mt. City Club House, Chattanooga, Tenn., S. C. Dodge, contractor; Phœnix Club House, Baltimore, Md., Southern Electric Co., contractors; Fourteenth Street Pumping Station, Chicago; the Greenwich Savings Bank, New York; Masonic Hall, Snug Harbor, Staten Island; Music Hall, Snug Harbor, Staten Island; Providence Trust Co., Providence, R. I.; Dr. D. B. St. John Roosa, residence, New York; the new building of the Metropolitan Telegraph & Telephone Co., Broad street, New York; Jackson Building, Union Square, New York; the Dunshee apartment house, Chicago; Jewish Temple, 5th ave. and 72d street, New York; and P. C. Hewitt's residence, No. 11 Lexington Ave., New York.

THE ENGINEERING EQUIPMENT CO.

Among all the new enterprises which have, within the last few months, been inaugurated in the electrical field, none have brighter promise of success than the Engineering Equipment Co., who have moved from their temporary quarters, at 73 Cortlandt street, to attractive offices in the fine new "Central Building," 143 Liberty street. They still retain the premises at 73 Cortlandt street for stock of belting, wires, etc., which they carry for convenience of customers who are not able to await shipments from the factories. It may be remembered that, as announced recently in these columns, Mr. Perine is general manager; Mr. A. L. Tinker, secretary and treasurer, and Mr. F. A. Magee, electrician, of the company. The others who are connected with the company devote themselves to the various branches of the business; and we understand that the success of this new company to date has been excellent, and the prospects are of the best. The company has been formed to handle the very best steam and electrical equipment materials, chiefly on large orders at close figures; and they are able invariably to quote as close as manufacturers on any goods that they handle.

Among the specialties which they control may be mentioned more particularly the following: The Underwood cotton-leather belts and belting specialties, in which they have a large and growing trade; the well-known and first-class Anderson line materials, including the Boston trolley for electric roads; the Habirshaw wires, cables and cores, the only line of wires recommended by the Government; the Patent indurated fibre pipe for electrical and other subways, which is by many considered to be the coming pipe and which is now greatly improved in manufacture; and the new Kellogg steel centre and side poles, for which the company are sole agents. Besides the foregoing they also handle the best boilers and engines, wooden poles, cross-arms, cars, trucks, etc.

It will be of interest to those who are in need of any of these materials to obtain a quotation from the Engineering Equipment Co.; and it is advised, if possible, that a call be made upon the gentlemen of the company at their new offices in the Central Building, where they will be very happy to meet the trade.

MR. C. F. BARNES has been appointed manager of the Indianapolis, Ind., telephone exchange.

WESTERN TRADE NOTES.

The Central Electric Company, Chicago, have come to the front with a new portable photometer, which seems to be especially appropriate now, when so much is being said about the efficiency of incandescent lamps. This machine will enable any station superintendent to measure the candle power of his lamps, and thus accurately determine exactly how much each lamp consumes. The instrument is being offered at a very moderate price, and promises to become popular at once.

Mr. C. E. Oldacre, the general agent of the Jenney Electric Motor Co., was in town recently for a few days. The Jenney Electric Motor Co. are now pushing their isolated, incandescent light business, and are now building some fine dynamos.

Mr. George B. Shaw, general manager of the National Electric Mfg. Co., of Eau Claire, Wis., was in town last week for a short visit.

Mr. A. D. Lundy, well and widely known in electrical circles, formerly chief engineer of the Sprague Equipment Co., and later chief engineer of the Southern District Edison General Electric Co., has formed a co-partnership with Mr. Frederick Sargent, the mechanical and electrical engineer, of Chicago. Mr. Lundy has been connected with the electric street railway business almost from its inception, and is one of the best posted men in this line in the country. They are located in handsome offices at 339 "The Rookery," Chicago, Ill.

Mr. G. A. Edward Kohler, Mr. Franklin W. Kohler and Mr. Thos. G. Grier will consolidate their interests on June 1st, under the name of Kohler Bros. & Grier. The firm will handle the well-known Eddy motors, heretofore sold by Mr. G. A. Edward Kohler. They will also be the sole selling agents for the U. S. for the Thwing Electric Co., of Chicago, manufacturers of the Gem incandescent lamps. In addition to this Mr. H. T. Paiste of Philadelphia, manufacturer of the Paiste switches and other specialties, has decided to open a Western office to facilitate the shipment and sale of his goods, with Kolher Bros. & Grier as managers. This branch of the business will be conducted under the name of H. T. Paiste. The firm contemplate adding to their line of specialties, as opportunities offer themselves, and as they are young men of ability and push, they have every reason to look forward to a successful career.

Mr. Thomas A. Edison visited Chicago last week. His trip was mainly in connection with the business of the local Edison Illuminating Co. here, but he also found time to look somewhat into matters electrical of the World's Fair, and expresses himself as highly pleased with the vigorous way in which Prof. Barrett is pushing forward the work. He is himself decidedly in favor of a united exhibit. He spent some time while here with Prof. Barrett and Mr. Frederick Sargent, the electrical engineer of the construction department, and was well pleased with the information these gentlemen furnished him with, and the active way they are working.

The Interior Conduit & Insulation Co. report through Mr. H. M. Underwood, their general Western agent, that the "Fair" building, now in process of construction, is to be thoroughly equipped with their conduit system.

The Electric Light Plant for the "Fair" building has been awarded, after a sharp competition among the representatives of the different companies, to the Sperry Electric Co., who will install a plant of 450 arc-light capacity, employing nine fifty-light machines to run these lamps. The Standard Electric Co., of Chicago, have obtained the contract for the incandescent lamps, which number 3,000 16 c. p. lights, and are operated by three 1,000 light machines. This company is building multipolar dynamos, which are giving universal satisfaction, by reason of their very perfect automatic regulation due to a special combination winding. The wiring will be done by the respective contractors for their systems. The deal was engineered through by Capt. C. F. Dunderdale, of the "Rookery" building, acting for the two fortunate companies. This installation will probably be the largest arc-light isolated plant in the country.

The Electrical Engineering Co. is one of Chicago's recent and prominent electrical organizations. The company have settled themselves in comfortable quarters at 603, Monon Building. The following gentlemen are the interested parties: Mr. E. M. Izard, well known in Western electrical circles as a member of the firm of Leonard & Izard, who, until their dissolution some time ago, was the general Western agent of the Edison Co.; Mr. R. H. Pierce, who was formerly the state agent of the Edison Co. for Wisconsin; Mr. R. E. Richardson, who, was associated with the Western Electric Co., in their lighting department, and Mr. G. W. Seymour. The company are carrying on the business of consulting and contracting electrical engineers, furnishing plans, specifications and estimates for the complete equipment, both power and electrical plant for electric light transmission and street railway equipment. They are agents for the dynamos of the Standard Electric Co. of Vermont, and the Perret motors, and general Western agents for the Clark wire. They are well backed financially and already receiving a large share of patronage, which augurs well for their future success.

NEW ENGLAND TRADE NOTES.

The Germania Electric Co. have removed their offices to Room 505, Exchange Building, 53 State street, Boston. Correspondence should be addressed, P. O. Box 3,068, Boston, Mass.

Mr. H. M. Nicholls has made the Redding Electric Company, of Boston, general selling agents, for New England, of the Star Electric specialties.

Mr. O. M. Johnston has connected himself with the Redding Electric Co., as traveling salesman. The Redding Co. are rapidly completing arrangements for vigorously pushing the sale of their goods, and there is already a brisk demand for their specialties.

The Shipman Engine Co., of Boston, have recently sold a 4 h. p. automatic engine to the Edison General Electric Co., for driving a dynamo in the Queen's County Alms House, Barnum's Islands, N. Y., and also a 4 h. p. engine to E. O. Hall & Sons, Honolulu, for driving a 40 light incandescent dynamo. These engines are fitted with boiler, with oil fuel, and automatically regulate the supply of fuel, so that the steam pressure is kept constant in proportion to the demand.

The Gould & Watson Co. are introducing another valuable article in the shape of a span wire insulator and turn buckle for use in electric railways. The insulator is illustrated and described in another column.

The Electric Gas Lighting Co. report business as extremely good this season. During April they did nearly three times as much as for a similar period last year. The demand for Samson batteries is unprecedented, orders coming in frequently for lots of 1,000. Col. Burnham is still in the far West, but he is expected home now about the first of June.

The New England Portelectric Co. gave a special exhibition this week of their system at Dorchester, to representatives of the Boston press. Mr. F. L. Pope, of New York, recently made an exhaustive report upon the practical working and possibilities of the system, and his estimates are extremely favorable. The Boston daily press are all loud in their praises of the progress made in the experimental track, a speed being now attainable of about 40 miles an hour. A full description of the experimental plant will be given in an early issue.

NEW YORK TRADE NOTES.

The Interior Conduit and Insulation Co., 43 and 44 Broad street, has issued an illustrated circular calling attention to the merits of its "twin conductor," recently described in these pages.

The C. & C. Electric Motor Co., 402 and 404 Greenwich street, have issued some timely literature relative to their fan motors and other outfits. They continue to do an enormous business in their fan equipments.

Stanley & Hall, 32 and 34 Frankfort street, have issued a very clever little circular anent their electric alarm, or "early morning call," which enables a man to sleep without worry as to being late, saves many a run for the train, and is a great promoter of peace and gaiety.

The Ball Engine Co., of Erie, Pa., E. T. Copeland & Co., agents, have issued some excellent campaign documents full of cold facts as to their engines for electric lighting.

The Thos. Murray Co., of 95 Liberty street, are putting in all the construction and equipments of the Rochester and Grand View Beach Railway. The Rae system is used. It is regular steam railway construction, and the cars will make 20 to 25 miles an hour. There will be 15 motor cars, and each will pull three trailers, if necessary. The road is to be ready by the end of this month.

Fort Wayne Plants.—The following sales have recently been made by the New York office of the Fort Wayne Electric Co.: 1,300 alternating incandescent lights, to the Asbury Park Electric Light and Power Co., Asbury Park, N. J.; 1,300 alternating incandescent lights, to the Richmond Light, Heat and Power Co., St. George, Staten Island, N. Y.; 650 alternating incandescent lights, to the Alumbrado Electrico de Barranquilla, United States of Colombia, South America.

The Eureka Tempered Copper Co., of North East, Pa., report large orders during the last thirty days from the Edison General Electric Co.; the Wenstrom Consolidated Dynamo and Motor Co.: Electro-Dynamic Co.; Wightman Electric Mfg. Co.; Thomson-Houston Electric Co.; Sperry Electric Mining and Machine Co.; Baxter Electric Motor Co.; C. & C. Electric Motor Co.; La Roche Electrical Works; McDonough Mfg. Co.; Shaw Electric Crane Co.; Thomson Electric Welding Co.; Colburn Electric Mfg. Co.; Ford & Washburn Electric Co., together with a large number of railroad bearings, and even with the dullness now prevailing in business circles, the demand for their tempered copper has constantly increased, instead of diminished.

THE
Electrical Engineer.

VOL. XI. MAY 27, 1891. No. 160.

THE JENKS POTENTIAL PROTECTOR.

THE "jumping" qualities of the electric current have been for many years relied upon as a means of securing immunity from damage to telegraph, telephone and other instruments which are subjected to occasional discharges of high potential. It was some time in the Forties that inventive genius was perhaps most active in this direction, and of the numerous forms of lightning arresters then put into practical use, Fig. 1, roughly outlines a good illustration. Here *a* and *b* are large plates supported on the roof of a telegraph office, so close together as to be connected by an atmospheric spark in case the difference of potential becomes too great, thus forming a shunt around the instruments in the building below, and even fusing together so as to maintain the circuit, in case the instruments burned out.

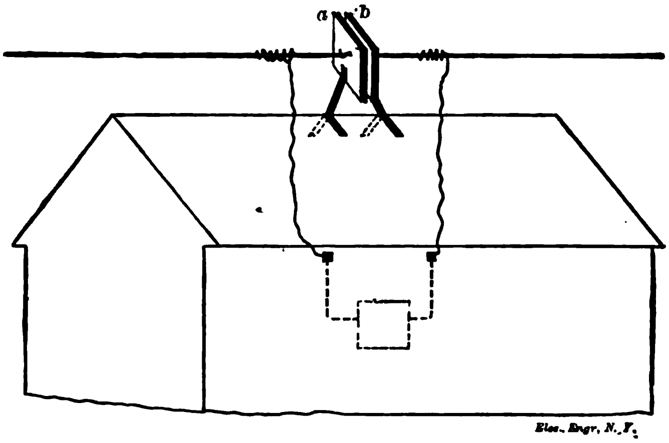


FIG. 1.—OLD FORM OF LIGHTNING ARRESTER.

Very early, also, films of paper were used to mechanically separate the plates, a dangerous pressure being sufficient to break down the fragile insulation and allow the plates to fuse together.

The application of these old cutouts to the protection of electric lamps, or the maintenance of the circuit in case of a rise of potential caused by the breaking of the lamp carbon, the failure of a feeding mechanism to operate, or a sudden rush of current from a lightning discharge or a short-circuit, did not probably involve invention. But the attempt to provide against very small variations of pressure, necessitated a delicacy of adjustment which none of the old forms possessed, and Fig. 2, illustrates how this delicacy may not only be secured, but maintained, by sealing or enclosing an air-space cutout or shunt so that it cannot be practically affected by dust or moisture.

It is a curious fact that the resistance of an air space, though practically immeasurable by any of our most delicate instruments, is overcome by a lower potential than an equal thickness of mica, paper or other mechanical insulator, which is so much better as a conductor as to be readily measured by an ordinary bridge.

This method of enclosing within an isolated cell, the air space which is to be relied upon to form the track of the current, is found by careful experiment to be absolutely essential in dealing with the low potentials from which delicate instruments must be protected, and the very close adjustment required to provide for a short-circuiting action with a predetermined potential may be secured by several methods. For the purposes of the Edison "municipal system" it is sufficient to bring the opposing conducting surfaces within about $\frac{3}{1000}$ inch of each other, while for other uses it may become necessary to narrow the space to about $\frac{1}{2000}$ inch.

Evidently adjustments as delicate as these can in practical work be made by the ordinary operative only by interposing between the electrodes a distance piece or washer of definite thickness, having one or more holes through which the discharge will occur, and this distance piece forms one of the most important points of the invention. It may consist either of mica, of perforated paper, silk bolting cloth or other suitable perforated film. By its means it is easy to set this potential cutout so that a rise of pressure from 150 to 200 volts, or even from 75 to 100 volts, will operate it with certainty, and cause the shunt to carry, either as a dead-short circuit or through a compensating resistance to the line beyond, or to ground, as the case may be, the normal current which might otherwise be broken, or the accidental current from some high pressure circuit, which might injure the instruments, and interfere with the circuit as a whole.

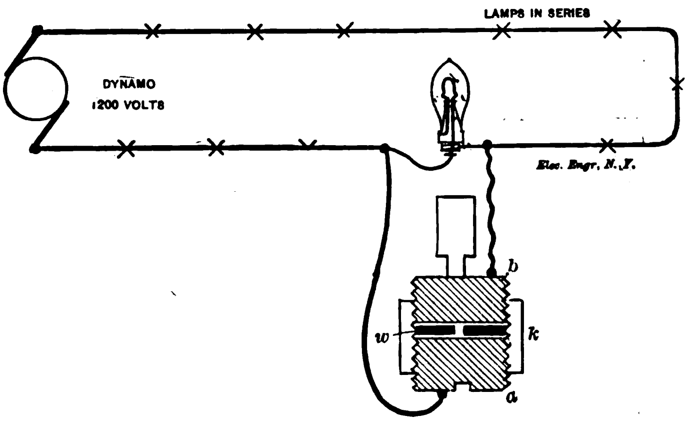


FIG. 2.—THE JENKS POTENTIAL PROTECTOR.

In Fig. 2, where the application to the "municipal" incandescent lamp is outlined, the size of the removable cell or button is exaggerated to show the construction. It consists simply of two metallic plugs *a* and *b* screwed into the threaded non-combustible moisture proof (lava) sleeve *k* against a washer *w* of mica, the space in the middle of the washer receiving the discharge. Several thousands of these have been used on Edison street lighting circuits for about three years. In February, 1890, the first test was made, by the New England Underwriters, of a combination of the air-space cutout and a circuit-opening device, as shown in Fig. 3, for the protection of telephone, district messenger, telegraph and other "innocuous" circuits, from the effects of crosses with their high pressure neighbors the arc, the alternating or the electric railway conductors, or from lightning. While many of the seventy-five forms of protectors then submitted for trial operated readily when a current flow followed a cross, the test demonstrated the absolute necessity of combining a fuse or magnet to open the circuit, with some device which would operate as this form does, namely, as the result of a rise in potential, without any current flow until a path is created by the protector.

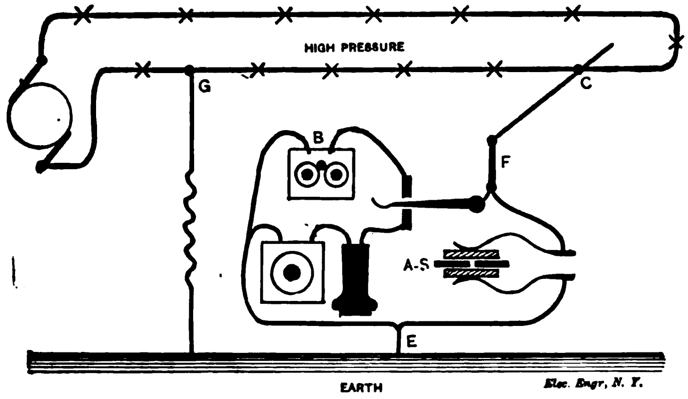


Fig. 3.—The Jenks Potential Protector.

Fig. 3, outlines a grounded telephone wire crossed with an arc, or other high pressure, circuit at the point C. If any leakage to earth from the arc circuit existed, as at G, a difference of potential will be set up between C and E, and a current will flow through the telephone or the bell B. If these be furnished with an air-space cutout A-S (forming a normally open shunt) and a fuse or electro-magnetic device F in the main circuit, the rise of potential will, if dangerous, cause a spark to jump from one plate to the other, reducing the resistance between the points C and E to a practical zero, and increasing the flow of current through the fuse so as to melt it and open the circuit before any harm can be done. Ordinarily this action will probably take place simultaneously at both ends of the line, and a telephone subscriber and the central station be alike protected.

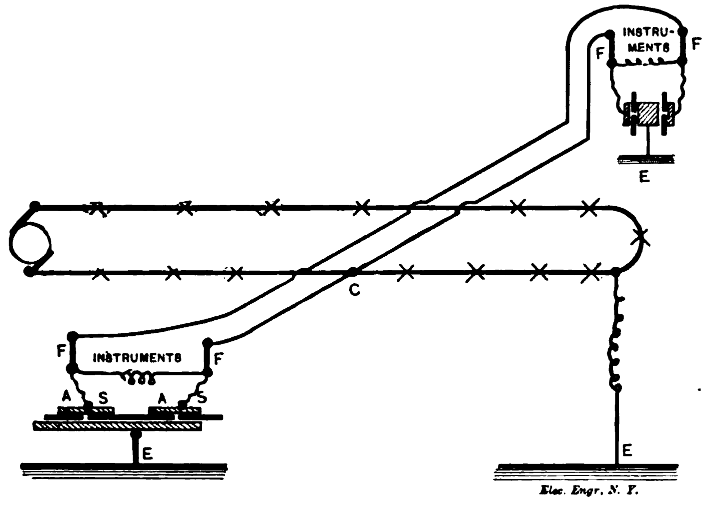


Fig. 4.—The Jenks Potential Protector.

Probably the most important application of this combination of potential and circuit opening devices will be to metallic circuits. Here it might be the case that absolutely no warning would be given of a cross of possibly dangerous character up to the moment that some one completed a path to earth by touching the telephone or the district messenger call box, or until leakage caused a fire. Fig. 4, shows the metallic circuit connections, and it is found that both wires at a given station will be instantly disconnected from the instruments when these conditions occur. This diagram also shows a very simple embodiment of the combination, a carbon strip being connected to earth and small carbon blocks to line, the separating medium being a perforated ribbon of mica. This is substantially the form which has within a year been introduced by the telephone companies, particularly in their long-distance work.

SIMPLE RULES FOR MEMORIZING ELECTRIC AND MAGNETIC ACTION.

BY

S. T. Moreland,

The purpose of this article is to give simple and easily remembered rules for determining, (1) the direction in which a magnetic needle will be deflected by a given electric current; (2) the direction of an electric current when the deflection of a magnetic needle is known; (3) the direction of the current produced in a conductor which cuts magnetic lines of force having a given direction. It is believed that the rules here given are simpler than those heretofore published. For understanding the rules the following assumptions must be borne in mind:—

1. That end of a freely suspended magnet which points north is called the north end of the magnet; by some called the north-seeking end.

2. The direction of a current of electricity is from carbon to zinc *outside* a cell composed of these elements.

3. The direction (sometimes called the *positive* direction) of a magnetic line of force, is the direction in which the north end of a magnetic needle points when placed on the line of force.

The rules, which will be explained and illustrated below, are as follows:—

Rule I. To find the deflection of a magnetic needle, grasp the current-carrying wire with the *right* hand, the outstretched thumb pointing in the direction of the electric current, then the fingers will go around the wire in the direction of the magnetic lines of force, and on whatever side of the wire a magnetic needle be placed its north end will be deflected in the direction in which the fingers go around the wire.

Rule II. To find the direction of a current, grasp the current-carrying wire with the *right* hand so that the fingers go around the wire in the direction in which the north end of a magnetic needle is deflected; the direction of the outstretched thumb is the direction of the current.

Rule III. To find the direction of the current produced when a conductor cuts magnetic lines of force, place the *right* hand with the fingers pointing in the direction of the lines of force and the palm so turned as to be struck by the moving conductor; then the outstretched thumb will give the direction of the current produced.

Rule I. may be verified by passing a current-carrying wire in a vertical direction through a horizontal platform on which a short magnetic needle, delicately pivoted, may be placed and its deflections observed. Suppose a current flowing up through the wire: Grasping the wire with the right hand, the thumb pointing up, the fingers will go around the wire in the direction in which the north end of the needle points. Apply the rule to the usual case of a wire in a horizontal position and lying in the magnetic meridian. Let the current flow from south to north, geographically speaking; then grasping the wire with the right hand, the outstretched thumb pointing north, we have the following cases :—

(*a*) *Above* the wire the fingers go towards the east; hence, if the needle be placed *above* the wire its north end will be deflected to the east.

(*b*) On the east side of the wire the fingers go *down;* hence, on that side the north end of the needle will go *down.*

(*c*) *Under* the wire the fingers go towards the west; hence, *under* the wire the north end of the needle will be deflected to the west.

(*d*) On the west side of the wire the fingers go *up;* hence on the west side of the wire the north end of the needle will be deflected *up.*

Rule II. may be verified by the vertical wire used to verify Rule I. As an example suppose a horizontal wire in the magnetic meridian carrying a current to be above a magnetic needle, and that we find the north end deflected to the east. To find the direction of the current, grasp the wire with the right hand in such manner that on the *under* side of the wire the fingers go towards the east; the outstretched thumb will be towards the south, and this will be the direction of the current. In the case of any coil of wire carrying a current, the direction in which the north end of the needle is deflected indicates the direction in which the lines of force pass through the coil, and if any part of the coil be grasped with the right hand so as to make the fingers pass through the coil in the direction of the lines of force, the outstretched thumb will point in the direction of the current.

Rule III. may be verified by means of a magnetic field where the direction of the lines of force are known, and a movable conductor forming part of a circuit including a suitable galvanometer. The rule is based on the very valuable suggestion, due to Mr. E. R. Carichoff, electrical engineer, that, just as a whip wraps around a rigid rod when it strikes one, so a line of force seems to wrap around any conductor which it strikes, and if we know the direction in which the lines wrap around the conductor we can tell the direction of the current by Rule II. Now the hand behaves just as the whip does; if we strike a rod with the palm of the hand (at right angles or nearly so to its length) the fingers will wrap around the rod, we have then only to put the right hand in the position of the lines of force, the fingers pointing in the direction of the lines and the palm turned so as to receive the moving conductor in order that the fingers may wrap around the conductor, the outstretched thumb will give the direction of the resulting current.

As an example, take a movable wire lying east and west and forming a part of a circuit, and suppose the wire moved *up.* The earth's lines of magnetic force go towards the north; the fingers of the right hand are therefore pointed north, and since the wire is to be moved up, the hand must be placed above the wire with the palm *down;* the outstretched thumb will then point west and this will be the direction of the current. If the wire be moved *down,* the fingers being towards the north, the hand being *below* the wire with the palm *up,* the thumb will point east and the direction of the current will be to the east.

It ought to be remarked that we do not suppose that a line of force which strikes a conductor actually wraps around it; on the contrary, we suppose the lines of force to cut across the conductor, *but the effect so far as the conductor is concerned is as if they wrapped around it.*

This use of the right hand is not the same as the use made of it by Prof. Jamieson in his excellent little books on Magnetism and Electricity, but the rules here given grew out of the reading of those books and the suggestion already mentioned, given me by Mr. Carichoff.

Mr. L. G. Hough, manager of the Indianapolis, Ind., Telephone Exchange, has resigned, and will take the agency of the Travelers Insurance Co., in that city.

RAIN CLOUDS AND LIGHTNING.

BY

Otis K. Stuart

In a recent article on "the Striking Distance of Alternating Electromotive Forces," Mr. Robert Shand, one of the ablest of the corps of assistants to Prof. Elihu Thomson, calls attention to a remark made by Prof. Thomson, concerning the electro-motive force of lightning discharges. Prof. Thomson has given considerable attention to the subject of auroras, lightning, and other atmospheric phenomena of an electrical nature, as was evidenced by his recent able lecture before the citizens of Swampscott, on the subject of thunder storms, and this remark is, therefore, worthy of more than passing consideration.

Mr. Shand states that he has heard Prof. Thomson remark (we suppose, during the course of conversation) that the "phenomenal values" of the electro-motive force, which are usually referred to in connection with lightning discharges, may be more fanciful than real. The electromotive force may break through one layer of the cloud and "act as a sort of electric wedge, capable of opening a path for itself, as it were, through many hundreds of feet." This suggestion is very curious as being in its way, confirmatory of Clerk Maxwell's idea as to the action of electro-motive forces through high resisting media. Clerk Maxwell, as Mr. Shand has said, likened this action to the splitting of wood by a wedge. First one layer of resistance is pierced by an electromotive force, then another layer, perhaps of less resistance than the first, then another and so on until, as in the case of wood, the whole resisting medium is pierced.

It is quite likely also that the conformation of the surface of a charged cloud may govern, to a large degree, the value of the electro-motive force of a lightning discharge. It has been noticed that after a flash of lightning there is frequently a sudden increased precipitation of rain. Even when a flash occurs during a violent down-pour, the precipitation immediately succeeding the flash is still more violent, and the rain drops are often larger than the average during the storm. If we suppose the cloud to project downwards from some part of its under surface, so that it presents a *point* to the earth's surface, it is clear that the cloud will be discharged from this point rather than from any other, not only because of the shorter distance between it and the earth, but also because the cloud does present this point. Gravitation acting upon the cloud would tend to accumulate the denser parts at its lower portions, and the projection thus formed would therefore serve as a comparatively good conductor to the passage of the electricity, which is another reason why the discharge would take place, with a moderate electro-motive force from this projection. Granting that the cloud behaves like a huge condenser consisting of successive layers of dielectric, the electro-motive force, piercing the interior or top layer of highest resistance, would find each succeeding layer in its downward path of lower and lower resistance, and its progress thus becoming easier and easier.

The characteristic phenomena of rain storms which are accompanied by lightning and thunder, are such that we may consider the rain clouds as huge, inverted, irregular cones, with the densest portions at the apexes. The centres of such storms are always the positions of greatest rain-fall, unless when affected by such disturbing influences as wind, temperature, etc. This volume of water precipitated decreases gradually from the center outward to the circumferential limits of the storm, where it is zero. There is generally a small area where the precipitation is very heavy, and all around this area there occurs a much lighter fall, the very lightest being at the storm's edge, which assumes the shape of an irregular circle.

The cloud thus acts as a wedge for entering the air between it and the earth. The striking distance is thereby decreased, there is a rough sort of point from which the discharge may readily take place, and the projection itself forms a comparatively good conductor to the passage of the electric current. If the projection were quite sharp (as might easily be the case, considering the dimensions of a cloud), and projected downward a considerable distance from the main body of the cloud, there might be a vivid discharge, of comparatively low electro-motive force and large current volume.

The same reasoning applies, though not with equal force, of course, to lightning discharges between cloud and cloud. Wind could readily cause a projection from one surface of a cloud toward another cloud. There would be a lessening of the distance between the too, and the formation of a projection, conical in shape, from the surface of one or both of them, and when the two clouds had approached each other close enough, the discharge, of comparatively low electro-motive force, would take place. If we consider the lighter portions of a cloud as driven more rapidly by the wind than the heavier, these latter, by lagging behind the former, would form such a projection, and in this case, the projection would be a comparatively good conductor of discharge current.

It is popularly supposed that the sudden down-pour of rain which generally at once follows a heavy lightning flash, is caused in some way by the flash itself. Of course, this is known not to be the case; and in view of the considerations above presented, it is quite possible that the sudden increased precipitation may be the real cause of the flash at that particular moment. By reducing the resistance through the striking distance, the increased precipitation offers a path for the discharge which, without this increased precipitation, it would be unable to follow; that is to say, the electro-motive force would not be high enough to pierce the dry air, but is high enough to follow the path of the multitude of large rain drops. Owing to the greater velocity of the light, we see the flash before we see the drops, but the latter really start on their journey before the former.

A PHOTOGRAPHIC STUDY OF THE ELECTRIC ARC, BASED UPON EXPERIMENTS MADE BY MR. J. C. McMYNN.[1]

BY PROF. EDWARD L. NICHOLS.

THE alternating current arc and the continuous current arc afford two entirely distinct fields of investigation. Candle-power, distribution of light, quality of light, temperature, efficiency, resistance, electromotive force necessary to maintain the arc, performance of the carbons under varying conditions; all of these are questions concerning which we have abundance of experimental data, so far as the continuous current arc is concerned. In the case of the alternating arc, however, these and many other points are still to be determined.

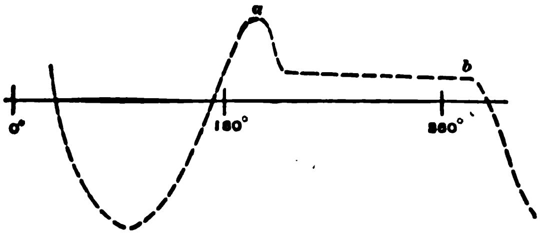


FIG. 1.—From Archbold and Teeple's thesis on the "Ball and Point" effect.

The arc lamp, fed by alternating currents, invariably hums and sings. The note, which is not to be mistaken for the hissing which we hear from continuous current lamps that are burning under improper conditions, possesses a definite pitch, determined by the rate of alternation of the dynamo. That the note is not due to the mechanism of the lamp itself is readily shown. The Jablochkoff candle, which is devoid of all mechanism, sings as merrily as the lamp with solenoid regulator; any form of hand-lamp will do the same. I do not remember having seen any definite statement concerning the source of this humming noise, nor any satisfactory discussion of the question. My attention was first brought to the very obvious explanation of the phenomenon by the study of certain curves of electromotive force, obtained by Messrs. Archbold & Teeple, in the course of an investigation of the alternating discharge between a ball and point.[2] These curves have recently been published. I produce one of them for the purpose of elucidation.[3] This curve was obtained by the well-known method of instantaneous contacts. The circuit under

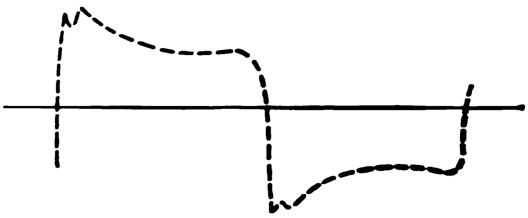


FIG. 2.—From Tobey & Walbridge's paper on the Stanley Arc Lighting Machine.

investigation was the high tension secondary of an induction coil, actuated by an alternating current dynamo, the E. M. F. of which followed the law of sines closely. In the circuit were placed a ball and point, the air space between them being such that the discharge would take place in one direction only, from ball to point. It was established, by the use of a revolving mirror, that an arc existed only during that part of each cycle represented by the horizontal portion of the curve. [*a*—*b*, Fig. 1.] Shortly after this curve had been obtained, the curves of Messrs. Tobey and Walbridge,[4] illustrating the performance of the Stanley arc

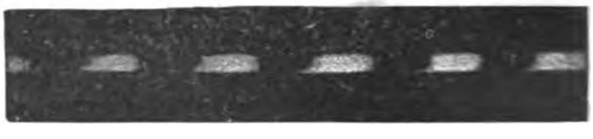


FIG. 3.—Alternating Arc. [Movement of plate horizontal.]

lighting dynamo, appeared. It will be remembered by those who heard their paper read before the Institute, that this machine, which gave very nearly the sine curve of E. M. F. when working through non-inductive resistance, showed curves very widely removed from that form when arc lamps were in the outer circuit.

Fig. 2 contains the curve of the arc-lighting machine when five lamps were in circuit. The relation of this curve to those obtained with the ball and point is evident. Here, also, the variation of the curve from sinusoidal form is to be ascribed to the periodic formation and breaking down of the arc, which happens twice in every complete cycle, instead of once, as in the case of the "one way" discharge of the ball and point phenomenon.

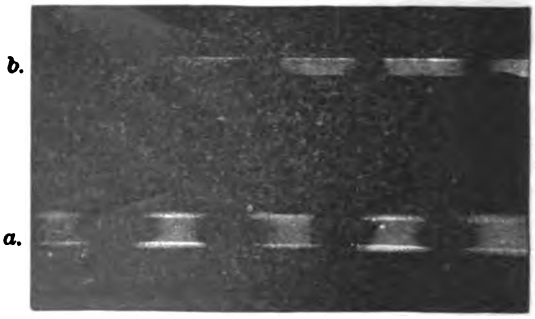


FIG. 4.—Alternating arc. *a*. Long arc (58 volts). *b*. Short arc (43 volts). [Movement of plate horizontal.]

After studying these curves it seemed to me unquestionable that the humming of the alternating arc is due to the rapid periodic extinction and re-establishment of the discharge, the effect being similar to that observed in singing flames. When, some months later, opportunity was found of viewing the image of the arc of an alternating current lamp in the revolving mirror, I was prepared to witness the extinction of the arc during a definite part of each alternation.

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 20th, 1891.

[2] See Archbold & Teeple; Thesis in MS., Library of Cornell University, 1889.

[3] See "The Alternating Electric Arc between a Ball and Point." *American Journal of Science*, Vol. 41, p. 1.

[4] Tobey and Walbridge; TRANSACTIONS, Am. Inst. Elec. Eng., Vol. 7, p. 367

Mr. McMynn's first step in the investigation was to photograph the arc under conditions which would bring out this phenomenon.

These photographs establish the intermittent character of the alternating arc beyond question. They also exhibit in a new light many interesting properties of the arc, some of which are already well-known, while others have not been noted. Of the many negatives already obtained, a few characteristic forms are given in the accompanying plates.

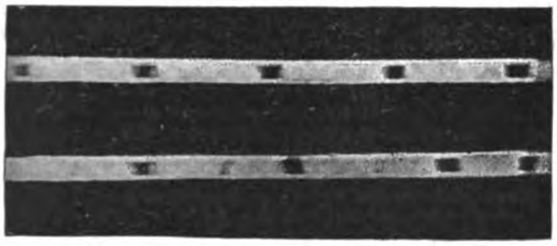


FIG. 5.—Alternating arc. [Movement of plate horizontal.]

Figs. 3, 4, 5 and 6 show the results obtained with plates moving in a horizontal direction, at right angles with the axis of the carbons of the lamp. Fig. 3 is an enlargement of one of the first negatives taken. The speed of the plate was moderate, the size of the image smaller than the arc itself. The plate contains but little detail. The carbons do not appear at all in the photograph, which shows little besides the periodic interruption of the arc. Inspection of Figs. 4, 5 and 6 shows that the greatest intensity resides neither in the arc itself nor on the incandescent carbons, but in a narrow region just at the ends of the arc. In this region, which, doubtless, is that where the so-called "contact resistance" of the arc occurs, the illumination is sometimes intermittent, as in Fig. 4; sometimes nearly uniform, as in Figs. 5 and 6. The relative width of the intervals of darkness and of light is also seen to vary greatly under conditions not yet determined. Fig. 6 represents the highest rate of speed given to the plate in any of these exposures. The image of a single alternation was in this case extended almost across the plate. No new features were brought to light, however, by this process of magnification.

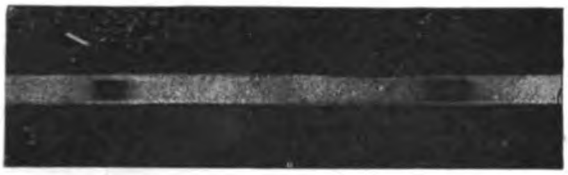


FIG. 6.—Alternating arc. [Movement of plate horizontal.] High speed.

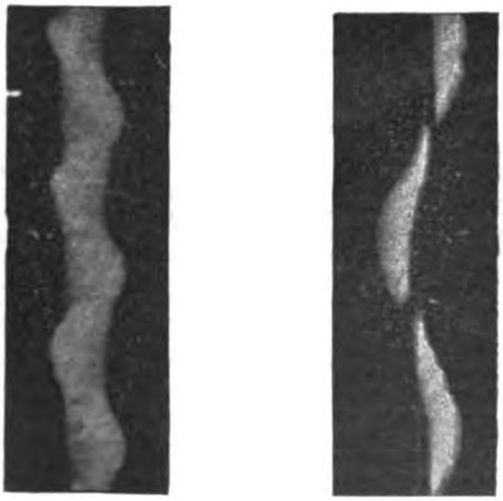


FIG. 7.—Alternating arc. [Movement of plate vertical]. *a.* Showing oscillations due to earth's field. *b.* Showing oscillations in a stronger field.

Figs. 7, 8, 9, 10, 11 and 12 were obtained by driving the plate vertically through the field, parallel to the carbons. An unlooked-for feature of all these plates was the oscillation of the arc from right to left in synchronism with the alternation period. Mr. McMynn suspected this vibration to be due to the action of the earth's magnetic field.[5] He was able to verify his view by comparing photographs made with the camera placed with its optical axis in the meridian with others in which the arc was viewed from the east or west. The disturbance was most marked in the former position and disappeared almost entirely from negatives taken in the latter. This point is well illustrated by Fig. 8 (*a* and *b*), which shows the image obtained from the north and from the east. The lamp in this case was supplied with cylindrical carbons. All the other photographs represent the arc between flat carbons. In a strong field produced by placing the arc nearly between the poles of a horse-shoe magnet, the lines of force being perpendicular to the axis of the lamp and parallel to that of the camera, the vibratory effect was much increased. [See Fig. 7 (B).] The bearded appearance of the arc in Figs. 9, 10 and 11 is common to all the negatives taken while the arc was in the strong field. The spines are supposed to be the paths of very minute and highly incandescent particles, expelled from the arc at a considerable velocity under the action of the magnetic forces. A continuous cur-

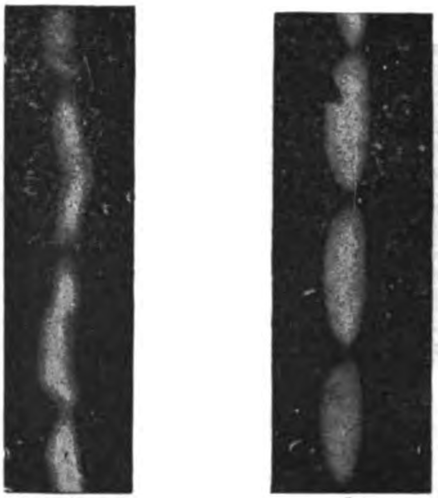
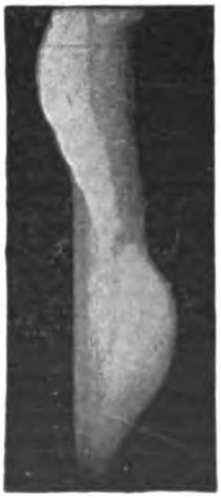


FIG. 8.—Alternating arc between cylindrical carbons. [Movement of plate vertical.] *a.* Arc viewed from North showing oscillations due to earth's field. *b.* Arc viewed from West.



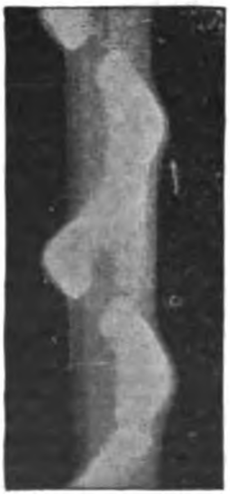


FIG. 9.—Alternating arc. [Movement of plate vertical; arc in strong magnetic field.]

FIG. 10.—Alternating arc. [Movement of plate vertical; arc in strong magnetic field.]

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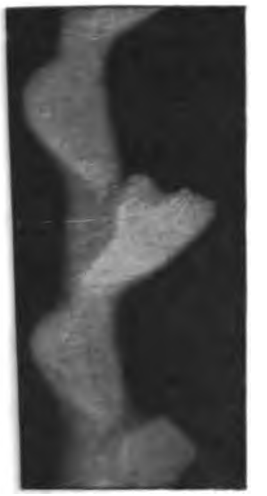
[5] It should be noted that Casselmann, as long ago as 1844, described the deflecting action of the earth's field upon the continuous current arc. (See *Poggendorff's Annalen*, 63, p. 588.)

rent arc, also in a strong field, the conditions being as nearly as possible those under which Figs. 9, 10 and 11 were taken, gave a negative of which Fig. 12 is a very imperfect representation. The arc was flaming, and it will be seen that while the path of the arc itself is an unbroken, straight trace, the flames, which show themselves to the right and left hands, are irregularly intermittent. The negative shows, moreover, that the flame to the right hand, in the figure, is finely striated, reminding one of the image of a hissing, sensitive gas flame, as the latter appears in the revolving mirror. This vibration, which must represent a pitch of several thousand vibrations per second, is, in all probability, the cause of the hissing of the arc.



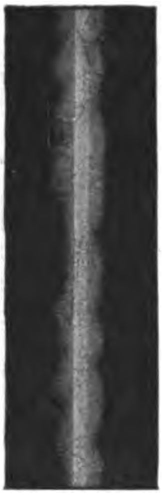


FIG. 11.—Alternating arc. [Movement of plate vertical; arc in a strong magnetic field.]
FIG. 12.—Continuous current arc. [Movement of plate vertical; arc in strong magnetic field; arc flaming.]

In this brief discussion I have left untouched many points which will suggest themselves to those who study Mr. McMynn's photographs. The interpretation of many of the features of these plates is at present rather obscure, but it is hoped that experiments now in progress will add something to our present knowledge of the phenomena connected with the alternating electric arc.

THE PERFECTION OF STATIONARY ELECTRIC MOTORS.[1]

BY FRANCIS B. CROCKER.

A STUDY of the history of the electric motor shows us that from the very beginning to the present time there has been a great tendency toward complicated, fanciful and unpractical designs, including outlandish forms of field magnets and unnecessary multiplicity of field cores and coils. In most cases also the mechanical construction has been very bad, the shaft being too small, the bearings being weakly supported, and the general finish and workmanship being rough and not up to the standard of first-class machinery. From the electrical standpoint the insulation has been very poor, and shares equally with imperfect mechanical construction, the responsibility for the numerous troubles and failures which have occurred with electric motors.

Electric motors are used for three different classes of work. First, transmission of power over considerable distances, for example from Niagara Falls to Buffalo; second, distribution of power, for example in a district of a city from a central station, and third, electric railway work.

The first of these classes of work usually requires large motors, over 50 or 100 h. p.; the second requires comparatively small motors, ranging between 1-8 and 10 h. p.; the third requires motors from 20 to 100 h. p. and a peculiar construction adapted to their special purpose. I purpose to consider in this paper motors of the second class for distribution of power especially.

It has long been my opinion that the proper way to design a good electric motor is to consider very carefully and systematically each part, first by itself, and then with reference to the other parts, and thus collect and build up the elements which are best, not only in themselves, but also in combination with each other, so that finally by putting and fitting these parts together with the best possible workmanship, the best result will certainly be obtained. Let us now take up the various parts of the electric motor, and consider each as a simple problem in designing.

The base should be a solid iron casting, flat and simple in form, and resting directly and squarely upon the base frame or floor, which latter should preferably be of wood to secure insulation. The base should be heavy to bring the centre of gravity low; in fact, this is the only part of the machine where weight is not only not objectionable, but very beneficial, and, since it is merely of plain cast-iron, the extra cost is insignificant. A heavy base does more than anything else to give great stability and strength to the whole machine, and is highly desirable in a stationary motor. The bearings should be directly and rigidly mounted upon this base, a simple fact that is often disregarded.

The field magnet should be *bipolar* except in the larger machines, above 10 h. p., on account of the great complication caused by the increased number of armature sections, commutator bars, field coils, etc., necessary in multipolar machines, and the narrowness of the neutral or non-sparking space on their commutators. The field should also be of the single magnetic circuit rather than the consequent pole type, because the former is more economical in wire and current required. A single circuit requires only 70 per cent. of the weight of wire, and 70 per cent. of the energy of magnetization that is required by a double magnetic circuit. A triple magnetic circuit or quadruple magnetic circuit is still more objectionable, requiring about twice as much wire as a single core of the same total cross-section.

The field magnet may be arranged with respect to the base described above in three general ways: First, the pole pieces may be set upon the base (Edison type); this form requires non-magnetic material, usually a zinc plate, to be interposed to prevent magnetic short-circuiting through the iron of the base; even with a zinc plate Hopkinson found 10.8 per cent. magnetic leakage through the base of the Edison-Hopkinson dynamo.

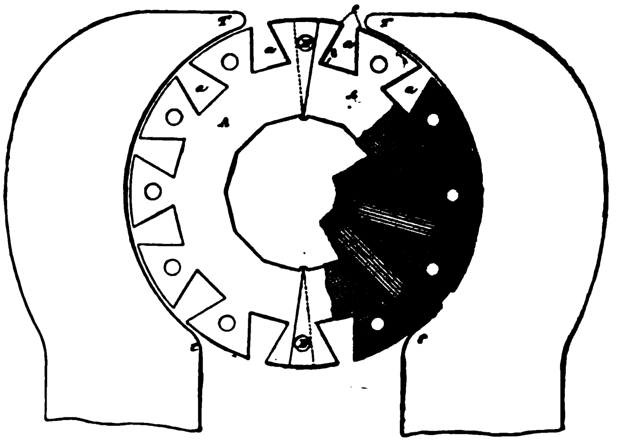


FIG. 1.—ARMATURE OF CROCKER-WHEELER MOTOR.

Second, the iron base may form one of the pole pieces (Manchester type). This is also objectionable on account of the greatly increased magnetic leakage, which is practically proportional to the surface exposed to the air, and the extension of the base necessary for the bearings, etc., greatly increases this surface, and also allows the magnetism to leak up into the shaft, pulley, etc., causing various troubles. This form has the further objection that it is of the consequent pole type, the disadvantage of which I have just pointed out.

Third, the iron base may form the yoke of the field magnet with the cores and pole pieces extending upward (Kapp or "inverted horseshoe" type). This plan has neither the leakage nor other faults of the other forms and possesses the great advantage that the pole pieces are removed as far as possible from the base, bearings, etc., thereby avoiding magnetic leakage; and the base being purposely made heavy for stability and strength, as already stated, is therefore exactly suited to being used as the yoke, thus performing two functions to the best advantage. There is, moreover, no objection to using a cast-iron base as the yoke to complete the magnetic circuit, since the heavy base I have insisted upon is of large cross-section, and therefore of ample magnetic permeance, and the increased size of the iron yoke does not aggravate the magnetic leakage because it is magnetically neutral. The field cores should be of wrought-iron, because the field wire surrounds them, and the use of cast-iron, which is of low permeability, would require a core of almost twice the cross-section, and therefore a much greater length of wire to obtain the necessary magnetizing force. With the smaller wrought cores the magnetic leakage would also be less. The pole pieces should also be wrought iron to reduce their size, and therefore their magnetic leakage, they being at the highest magnetic potential of any part of the machine. Magnetic leakage is objectionable, not only on account of wasting lines of force, but because it affects electrical instruments, watches, etc., in a very troublesome manner.

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 20th, 1891.

The field magnet cores and pole pieces being preferably of wrought-iron, the question of uniting them to the base and to each other next arises. Since any considerable fitting or working of wrought-iron is difficult and costly, the best solution of this problem certainly seems to be to drop-forge the core and pole piece in one piece. This also permits the bore or space for the armature to be perfectly formed at the same time. In connecting these cores to the cast-iron base, it is practically essential to set them into it in order to get sufficient contact and strength; since the ordinary butt joint between wrought and cast-iron limits the magnetic conductivity almost as much as if cast-iron were used throughout. This method of putting the magnetic circuit together reduces the work of fitting wrought-iron to a minimum, which work is the only objection to the use of wrought-iron. The supposition that cast-iron is cheaper than wrought for magnets is a fallacy, as its permeability is as much below that of wrought iron as is its price, both being about one-half.

The field coils should of course be perfectly insulated, a result which can be accomplished with certainty by winding them on a solid spool of material which is fire and water proof and highly insulating. These spools should never be made of material that softens by accidental heating of the wire, as this would allow the wire to cut through and make a "ground" on the core, which is just what the spool should prevent. I have tested spools of this kind which cut like cheese when a wire heated by a current was applied to them, this being a very effective method of testing this point.

In regard to the choice between the ring and drum forms of armature, the advantage of the drum is that it is easy to support mechanically, but it is difficult to wind, and more serious than anything else is the fact that the wires of a great difference of potential cross or approach very near each other, causing great liability to short circuit. The ring armature is somewhat hard to support mechnically, but the winding does not tend to slip out of place or pile out on the ends, and wires of the greatest difference of potential come at the greatest distance apart; that is, on opposite sides of the armature. This is of the utmost importance in the case of high voltage machines. In the case of large ring armatures, or those with few turns of wire, there is little trouble in winding; but in the case of the small ring armatures, or where a great number of turns of wire are used, the ring should be split in halves to facilitate winding, and put together afterward when wound.

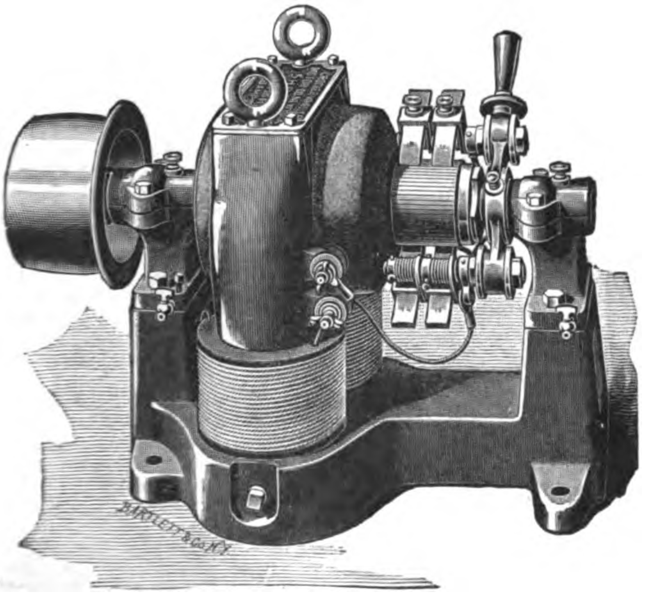

FIG. 2.—CROCKER-WHEELER MOTOR.

The armature should have teeth or projections upon it in order to secure the following advantages:

First, to reduce the reluctance of the magnetic circuit and the weight of wire and energy of current required to magnetize it. Second, to hold the wires in place and prevent them slipping tangentially on the core, there being a tangential pull of about 160 lbs. on the wires of a 10 h. p. armature 8 in. in diameter running at 1,000 R. P. M. Third, the teeth protect the wires from mechanical injury, since any blow or pressure which the armature receives comes upon them instead of upon the armature wire.

In the trapezoidal tooth armature, the teeth are considerably wider at the top than at the bottom, which of course makes between the teeth a slot which is wider at the bottom than at the top. This shape of tooth and slot has the following advantages over those of the ordinary toothed armature: Frst, the wire is more completely held in place, being held against centrifugal force as well as against tangential force; second, the wire is also more perfectly protected mechanically since it is almost entirely surrounded by iron; and third, the armature presents an almost unbroken magnetic surface to the pole pieces, thereby reducing to a minimum the reluctance of the air-spaces in the magnetic circuit and the magnetic leakage, and avoiding Foucault currents and loss of energy in the pole pieces. This trapezoidal form of slots and teeth can be still further taken advantage of by giving the former a shape which exactly agrees with the form of a section of winding on the inside of a ring, as shown in Fig. 1, the interior spaces for winding being divided into the necessary number of sections by radial lines. This exact conformity between the inside and outside of the winding makes a perfectly symmetrical coil, with no tendency for a single turn of the wires to cross at any point, and the coils on the inside occupy the whole space with the greatest possible advantage, whereas ordinarily the interior of the ring is liable to be overcrowded with wires. The trapezoidal form of slot is particularily economical as regards winding, for the reason that there are a greater number of turns in the inner layers which are shorter, and fewer turns in the outer layers, which are longer, as shown in Fig. 1. The armature teeth make it easy to support the ring perfectly, since the bolts for carrying it may pass through the teeth without interfering with the winding. The perfect insulation of the armature core is of the utmost importance. The best material and the most complete covering should be used, and the greatest possible care should be exercised to avoid short-circuits, "grounds," or broken wires.

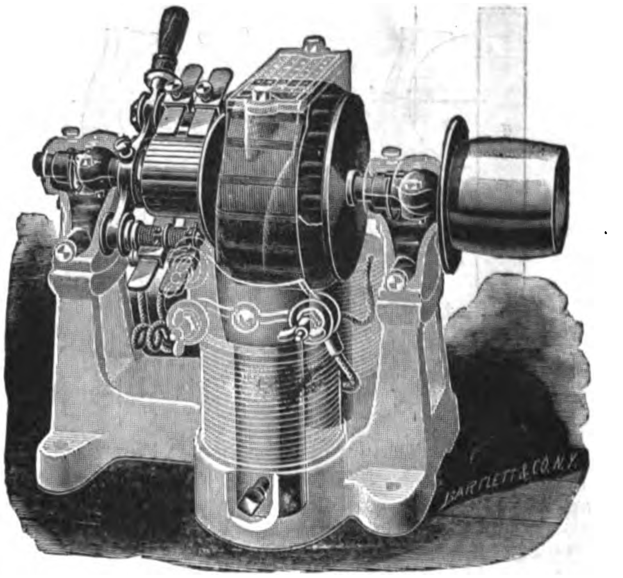

FIG. 3.—CROCKER-WHEELER MOTOR.

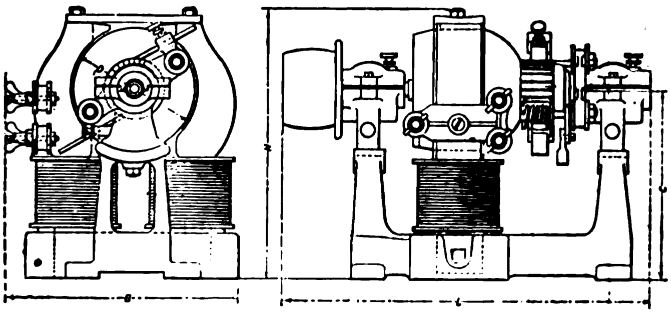

DIAGRAM SHOWING DIMENSIONS OF CROCKER-WHEELER MOTORS.
(*See Table.*)

The efficiency should, of course, be as high as possible, and is made a maximum by reducing all elements of loss as far as possible. These losses are, current to magnetize field, loss due to armature resistance, friction, resistance of air, Foucault currents, and hysteresis. It has always seemed to me that if a machine can be run for one or two hours at full load without any part becoming overheated, the efficiency of that machine must be high, unless the machine is very large and heavy for its power, in which case the surface for radiation and conduction would be great. This fact is more absolute than any efficiency test can possibly be, and very small losses which an efficiency test might not disclose would be indicated by local heating, if, for example, the effects are allowed to accumulate for a half hour of steady running.

I can best illustrate the foregoing statements and recommendations by describing the set of electric motors designed by Dr. S. S. Wheeler and myself. They were developed by precisely the same process of reasoning as that given in this paper.

Fig. 3 shows the general view of the motor; the fields are put together according to a method, illustrated in Fig. 4, which consists in drop-forging the core and pole piece in one piece and exactly to shape; then mounting it upon a holder in such a way that the ends of the cores are trimmed with exact reference to the armature bore; and holes being bored in the cast-iron base the proper distance apart, the cores are set into it to the depth they are trimmed off and produce a space for the armature exactly suited to it. The field cores set into the base are shown in the skeleton drawing, Fig. 3.

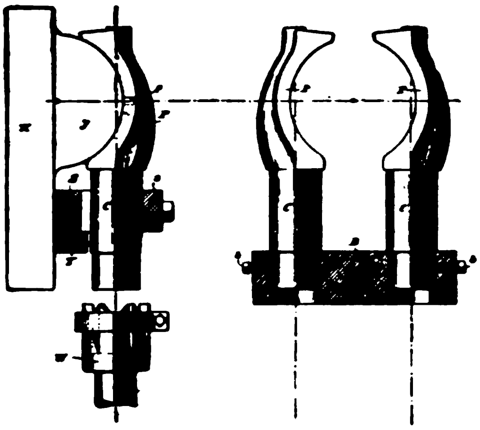

Fig. 4.—Method of Assembling Fields.

The magnetic circuit produced by this method is excellent. In the first place, there are only two joints and these are of very large surface and fit perfectly, being where the cores fit into the base. The surface of contact of each of these joints is about four times the cross section of the core, and therefore about twice the cross-section of the equivalent cast-iron. The core and pole piece being made integral, avoids any joint between them as well as any necessity for expensive work in fitting them together. In fact, the only machine work required in fitting the fields to the base is simply trimming off superficially the ends of the cores and reaming the two holes in the cast-iron base, these holes being cored out in the casting.

TABLE DIMENSIONS, &c., CROCKER-WHEELER MOTORS.

Horse Power	Net weight lbs.	Speed	Pulley		Size of Motor over all			"G." Length between bolt holes in base	"K." Breadth between bolt holes in base	Diam. Shaft ins.	"D." Diam. Armature ins.	"C." Height of shaft centre from base of Motor
			"P." Diameter ins.	"F." Face ins.	"L." Length ins.	"B." Breadth ins.	"H." Height ins.					
⅛	18	2,100	Grooved, 1⅛ or Flat, 1⅛	5/16 1	7⅜	5⅜	7⅜	4⅜	2⅜	¼	3⅜	5 15/16
⅙	26	2,000	Grooved, ⅝ or Flat, 1⅛	5/16 1	9⅛	7⅜	8⅜	6⅜	3⅛	5/16	3 11/16	6⅜
¼	26	1,800	2⅜	1¼	9⅛	7⅜	8⅜	6⅜	3⅛	⅜	3 11/16	6⅜
½	65	1,500	3	2	14⅛	9⅜	10⅛	9⅛	4 7/16	7/16	4⅛	7⅜
¾	100	1,350	3⅜	3	18⅛	11	13	11⅜	5⅜	11/16	5⅛	9
1	157	1,050	4	3⅜	19	13⅛	15⅜	12⅛	7	⅞	7 1/16	10⅜
2	290	1,050	6	3	25	15⅜	18⅜	13⅛	9⅛	1	8⅛	11 1/16
3	300	1,000	6	4	26⅛	15⅜	18⅜	18⅛	9⅛	1	8⅛	11 1/16
5	485	1,000	7⅜	4⅜	28	18⅜	21	18⅜	9⅛	1⅛	9⅛	12⅛
7½)												
10)												

The armature is made with trapezoidal teeth, as shown in Fig. 1, and having an almost unbroken surface of large extent exposed to the pole piece with a clearance of only one-sixteenth of an inch, the magnetic reluctance of the air gap is reduced to the lowest possible value. This reduces the amount of wire required to excite the field to such an extent that only very short field coils and cores are needed, being only about one-third or one-quarter of the length required with armatures having no teeth and the ordinary air gaps in the magnetic circuit. This small quantity of wire on the field, amounts to only 12 pounds in a three h. p. machine and 16 pounds in a five h. p. machine. It has not only the advantage in economy of wire, but also makes the machine very efficient as regards current consumed in the field, being less than two per cent. in the two machines referred to. The reduction of field wire and length of coil required, is particularly important in bringing the shaft of the machine down sufficiently near the floor to give the machine stability and steadiness in running. In the type of motor described, the shaft centre is less than a foot from the floor in the three h. p. size, and is just about the proper height to make the pulley, belt, gear wheels or other mechanical connections clear the floor and have sufficient room to work properly. This complete overcoming of the heretofore serious objection to the "inverted horseshoe" type makes a thoroughly satisfactory field construction without any of the disadvantages of all the other forms.

The actual results obtained from these motors are given in the following table and include the various mechanical, electrical and magnetic constants of the machine. All the sizes of this type of motor are made almost exactly the same in design, proportions and construction and differ only in scale, hence a description of one machine applies to all, with proper allowance for difference in size.

Data of three h. p. Crocker-Wheeler motor, designed for 115 volt constant potential circuit:

Total weight	350	lbs.
Weight of field wire (No. 24 A. W. G.)	12	lbs.
Weight of armature wire (No. 13, A. W. G.)	11	lbs.
Resistance of field	810	ohms.
Resistance of armature	.4	ohm.
E. M. F. of circuit	115.	volts.
Total current at full load	24.3	amps.
Current used to excite field	.37	amp.
Percentage of current used in field	.015	
Total current required to run free	1.9	amp.
Percentage of total energy to run free	.08	
Commercial efficiency	.80	
Armature speed	975.	r. p. m.
Total magnetic leakage or waste lines of force	.17	

$$\text{Magnetic efficiency} = \frac{\text{Lines through armature}}{\text{Total lines of force}} \ldots\ldots .83$$

The above data for the most part explain themselves, but I desire to call attention to several particularly interesting points.

The weight of field wire is extremely small, being only 12 lbs., compared with about 40 to 50 lbs. in most machines of this size. I actually found the weight of field wire to be 60 lbs. in a type of motor of equal capacity, which is claimed to have the best possible magnetic circuit.

The table also shows the current used in field to be only 1½ per cent., which is remarkably low for machines of this size, which usually require about five per cent.

The current required to run free, at full speed, is also exceptionally small, being only eight per cent.

The commercial efficiency is high for a motor of this size, particularly when the very low speed is considered, because an increased number of turns of wire on the armature is required to make up for the reduced speed, and this augments the armature resistance and causes loss. The efficiency does not vary more than about one per cent. from half to full load, which is quite an interesting fact.

The speed, it will be noticed, is very low for this size of machine.

The magnetic leakage or loss of lines of force is extraordinarily small, amounting to only 17 per cent., and giving what may be properly called a magnetic efficiency of 83 per cent.

This small magnetic leakage is due to the design of the field magnets. In this connection it should be remembered that Hopkinson, in his classical investigations of the magnetic circuit, found that there was 24.94 per cent. magnetic leakage in the Edison-Hopkinson machine. I may also state that Mr. A. S. Ives, student in Electrical Engineering at Columbia College, found 40 per cent. leakage in a well-known 400 light dynamo of a recent, though not the very latest, type.

In conclusion, I would state that it is obviously impossible, in one paper of reasonable length, to completely treat the subject of motor design, but I have attempted to bring out the most important points, and lay before the Institute the best results of considerable study and experimental work on the part of Dr. Wheeler and myself in the direction of improving and perfecting the design and construction of stationary electric motors.

The ideas I have advanced are embodied in a large number of actual working machines which are open to anyone for examination and criticism.

THE COPPER PRODUCTION OF THE WORLD.

Messrs. Merton's annual statistics of the copper production of the world show that the output of 1890 reaches the highest figures yet attained. The production of the United States has more than doubled since 1883, and last year's output was upwards of five times that of 1879.

TESLA'S EXPERIMENTS WITH ALTERNATING CURRENTS OF HIGH FREQUENCY.

THE Wednesday evening session of the American Institute of Electrical Engineers was held in Prof. Dwight's room, Columbia College, and will long be remembered by those present, not only on account of the brilliant experiments shown, but also for the many possibilities which it suggested in the development of the artificial illumination of the future. For the purpose of his experiments, Mr. Tesla employed the alternating machine with 384 poles, described in THE ELECTRICAL ENGINEER of March 18, 1891, which, when run at full speed, permitted him to obtain 20,000 alternations per second. The currents of this machine in all of Mr. Tesla's experiments were first run through a condenser in order to avoid the possibility of injury to the machine. The machine itself was set up in the electrical workshop of the college and was driven by an electric motor, the speed of which could be varied by a switch on the lecture platform.

Mr. Tesla introduced his subject by the remark that modern science has been able to make rapid strides by the recognition of ether as the medium of transmission of vibrations of various forms which manifest themselves to our senses. We are therefore now able to see things in a different light than was formerly the case, and, being tolerably well able to explain them, the truth cannot be hidden much longer. The answer to the question, "What is Electricity?" we were not yet prepared to give. We were justified in assuming, however, that electric phenomena are ether phenomena, and we may consider the phenomena of static electricity as phenomena of ether under strain, and those of dynamic electricity and electro-magnetism as phenomena of ether in motion.

Mr. Tesla, while expressing the highest consideration for the work of Dr. Lodge, was not in entire accord with the views advanced by him, which he considered to be more of the nature of ingenious explanations than of a probable theory, Mr. Tesla contending that there can be no two electricities.

Alluding further to the electro-magnetic theory of light, and to the Hertz experiments and those of Dr. Lodge and their application to the production of an efficient source of light, Mr. Tesla considered the electro-magnetic waves as unavailable for the production of luminous effects, for the reason that long before we could reach the necessary frequency the conductor would become opaque to the passage of the waves. Mr. Tesla thought that electro-magnetic waves, unless they have the frequency of true light waves, cannot produce luminous effects, Not so, however, with the electrostatic waves or thrusts. These, no matter what their frequency, can excite luminous radiation. He reasoned that the static effects in the Hertz and Lodge experiments were excessively small, due to the fact that they were produced in a practically closed coil, the spark acting as a bridge, making the coil practically continuous and depressing the potential. To obtain the desired difference of potential we must work with an open circuit generator of high potential of high frequency to enhance the electrostatic effects, and it was the recognition of this fact which led Mr. Tesla to the results he showed.

In carrying out this idea of obtaining enormous differences of potential, Mr. Tesla at once encountered the difficulty of obtaining the requisite insulation for the induction coil employed by him. His experience demonstrated that what we consider the best insulators, such as glass and rubber are inferior to others, not formerly so considered, such as oil and wax. Mr. Tesla then started a spark coil in action, the primary of which was in connection with his alternator which was speeded to give from 10,000 to 11,000 alternations per second. The coil emitted a clear note, which rose as the number of alternations was increased. As the discharges took place between the terminals of the coil, an exhausted Geissler tube held in proximity to the discharge did not light, but upon blowing out the arc the tube lighted up, which was due to the rise of potential caused by the rupture of the arc. This effect Mr. Tesla considered as purely electrostatic.

Mr. Tesla then showed the influence of insulated bodies having considerable size upon the spark length, demonstrating the effect of capacity upon the nature of the discharge. Thus when we attach an insulated body to the terminal of the coil, the potential may be raised or lowered. He showed this by wrapping an insulated wire of about one foot in length about one terminal of the coil, and touching the other terminal with a brass sphere held in the hand; under these conditions streams of light emanated from all sides of the wire. When the sphere was removed, however, the streams disappeared almost entirely. He then cut off the wire in successive lengths, and the stream discharges became more marked and brilliant. He then attached a fine platinum wire to the terminal, which also showed the streams to a remarkable degree, and kept up a continuous vibration to and fro. He also showed a pinwheel effect, the wheel being rapidly rotated with streams issuing from the two points. Another experiment consisted in attaching two spheres of about four inches diameter to the terminals. The spark passes first between the two points nearest to each other on the spheres, then works up toward their tops, is extinguished and is re-established at the first point, this being continuously repeated. The neighboring exhausted tubes and lamps were illuminated and extinguished in unison with the action of the spark between the spheres. These Mr. Tesla pointed out were not electro-magnetic vibrations like the Hertz waves. He showed how by the use of the dielectric the spark is induced to jump between the separated spheres, due to the increase in the specific inductive capacity of the medium, and he also demonstrated that the streaming discharge passed easily through thick glass plates, rubber plates and a book. Mr. Tesla then showed these static effects in a non-striking vacuum. A tube of this nature when connected to the machine glowed brightly, and the terminals became incandescent. Mr. Tesla then remarked that if, instead of using a filament in a lamp—which necessarily limited us in the degree of incandescence which we could practically employ,—we could employ solid blocks of carbon, much higher efficiency could be obtained. Based upon this reasoning, he had constructed a lamp which he showed, containing two blocks of carbon in a non-striking vacuum. When connecting these two carbons to the two terminals of the coil or one to one terminal and the other to a body of some size, the blocks can be raised to high incandescence.

Mr. Tesla also showed a lamp with but a single rod filament in a non-striking vacuum with no outward connection. The energy is entirely transferred by condenser action through the medium of condenser coatings in the base of the lamp. He also pointed out how the brilliancy of the lamp could be varied by simply altering the relative positions of the condenser coatings. This Mr. Tesla followed by demonstration of the phenomena with an unexhausted globe, and a single filament mounted therein. The filament when connected to one terminal of the coil heats up to bright incandescence and spins around in the globe. He also demonstrated the heating by the use of Crookes' well-known apparatus consisting of mica vanes mounted above a platinum wire, which was brought to incandescence by connection with one terminal of the coil, and rotated the mica vanes.

In order to still further verify the conclusions that the electrostatic effects are alone active, Mr. Tesla placed a Geissler tube at right angles to the coil and at its centre. In this position the tube did not light up. When placed at the ends, however, the tube lit up brilliantly and gave sufficient light to read by. Mr. Tesla showed both uranium and yttria tubes.

He then showed how exhausted tubes could be made to glow in an electrostatic field. For this purpose two large sheets of zinc were connected to the terminals of the machine at a distance of about 15 feet apart. The tube when placed between these sheets glowed brilliantly and could be moved about freely. Mr. Tesla remarked that, by merely creating such a field in a room, the mere suspension of the tubes in the room would afford the desired illumination.

Coming to the physiological effects, Mr. Tesla adjusted the conditions so that by touching one terminal with a brass sphere he raised the potential of the coil so enormously that a stream of light came out on the other terminal, and he estimated the difference of potential to be nearly 250,000 volts, and then performed the remarkable experiment of receiving the total discharge through his body, protecting his hands from burning by the brass balls held in his hands.

He then lit up lamps by holding them in contact with one terminal or near to the coil.

The lecturer then came to another class of experiments. He stated that he had used a system of conversion from high tension to low with the enormous frequencies of the condenser discharges. Mr. Tesla then showed an interesting experiment which consisted in passing the converted currents, produced in the manner just described, through a copper bar [illegible] inch in diameter and bent into a loop. Ordinarily such a bar would constitute a short circuit, but Mr. Tesla succeeded in bringing lamps stretched across the parallel sides of the bar to incandescence, demonstrating that the impedance in the loop connecting the two sides was so great as to practically prevent the current from passing through it and hence acting upon the lamps in the manner described. He also pointed out the existence of modes on the bar. His method consists in continuously charging and disruptively discharging a condenser into the working circuit, the charging of the condenser being effected by a coil operated either by alternating or direct currents. By this means any desired higher frequency may be obtained from any lower frequency.

Mr. Tesla concluded his experiments by exhibiting in action a simple alternate current arc lamp, operated by currents direct from the machine giving 20,000 alternations per second. The light was beautifully steady and the arc entirely free from the hum accompanying arcs operated with currents of low frequency.

We have given but the merest outline of the many beautiful and highly suggestive experiments made by Mr. Tesla. Notwithstanding the fact that Mr. Tesla excited the intensest interest of his audience for three hours, he was nevertheless unable, for lack of time, to bring before them many experiments, some of which, he said, were even of a more striking nature than those brought out.

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Vol. XI. NEW YORK, MAY 27, 1891. No. 160.

Many valuable inventions have been founded on the discovery of simple facts, but such inventions can never be perfected unless the principles of science upon which they are based are known.—Joseph Henry.

THE TESLA EXPERIMENTS.

WHILE the interest in all the papers of the annual meeting of the American Institute of Electrical Engineers was sustained throughout the sessions, there can be no question that most interest centred upon the lecture delivered by Mr. Tesla on the phenomena of alternating currents of high frequency. Mr. Tesla's recent utterances on this subject had served to excite the curiosity of many, and we believe that a thorough analysis of the work accomplished by Mr. Tesla, as exhibited in the experiments shown by him, will lead to the conclusion that those expectations have been more than realized. The brilliant researches and experiments inaugurated by Dr. Hertz, and followed up by Lodge and others, which served to verify the theory that the phenomena of light were referable to electro-magnetic vibrations of the ether, seemed to point out an apparently easy way of obtaining illumination directly through the medium of electro-magnetic vibrations. It has remained for Mr. Tesla, however, to recognize that for the production of light, electrostatic effects are needed. He reasoned that it was impossible to obtain primarily the desired electro-magnetic effects, since we must work with bodies of infinitesimal dimensions which can be acted upon only electrostatically, it being evident that an electro-magnetic wave cannot excite luminous radiation unless it be a true light wave. To produce longer electro-magnetic waves would, therefore, be of no avail; but this is not the case with electrostatic waves or thrusts. These, no matter what their length, Mr. Tesla demonstrates, can excite luminous radiation by disturbing molecular or atomic charges, causing the molecules or atoms to vibrate and to emit light; and since electrostatic effects are dependent upon the conjoint effects of potential and frequency, this reasoning led him to the investigations, the results of which were shown.

Continuing the train of reasoning followed by Mr. Tesla, we see that he has recognized further, that electrostatic effects of such character are available in many ways for the production of light. Thus he showed that if a filament in a globe be connected with only a single terminal of the source, in consequence of the rapidly alternating potential, the molecules of the gas are strongly attracted and repelled, and in this manner by their impact a filament may be kept at incandescence with only one wire. With these facts before him, and recognizing further that the employment of a filament is a bar to the attainment of higher efficiency on account of the limited degree of incandescence at which it can be run, Mr. Tesla reasoned that two blocks of a refractory material may be placed in a perfectly exhausted globe and sufficient energy transferred by condenser action to keep the blocks at incandescence, thus allowing a much higher efficiency in the production of light by reason of the possibility thus afforded of maintaining the carbons at a much higher degree of incandescence. Mr. Tesla has also shown that it is perfectly practicable to transfer sufficient energy to the medium, from a single block or filament placed in a perfectly exhausted globe and connected with one wire to the source, to keep the filament at the desired incandescence. Another and most important fact which he demonstrated was the practicability of using tubes of rarified gas without any terminals as practical sources of illumination by simply creating an electrostatic field near them, and also of using lamps without leading-in wires. All these results can evidently only be obtained by the use of enormous frequencies and potentials, or, in other words, powerful electrostatic effects, the study of which was made difficult in consequence of the fact that in previous experiments, looking to this end, the static effects were excessively small, owing to the fact that the coil was short-circuited through the low resistance discharge between the knobs of the discharger. The method of conversion devised by Mr. Tesla, allowing of the use of any frequency, enables us to undertake a much more exact and easy study of the effects of short waves. Again, his experiments with the lamps burning when connected with their terminals to a short, thick copper bar, are extremely interesting. The possibility of verifying nodes on the bar by simply using a Cardew voltmeter will be of great value in investigating these phenomena. His experiments also prove that while, with alternating currents of low frequency, such as are now generally employed, the effects of self-induction must be largely considered, those of high frequency accentuate largely the condenser effects which have to be allowed for accordingly.

It would lead us too far to enter into all of the numerous points suggested by Mr. Tesla's lecture, but he showed enough to warrant the assertion that in a comparatively short time the practical application of these principles to the production of artificial illumination will be an accomplished fact.

THE ELECTRICAL EXHIBIT AT THE WORLD'S FAIR.

The latest suggestion, and one that contains many points of merit, for the location of the electrical display at the World's Fair, is to place all the generating plant in a portion of the Machinery Annex. It is then proposed that a subway be constructed from the Machinery Annex to the Electric Building, in which all the cables and wires transmitting electrical energy for the respective exhibits of the various companies will be placed. In addition to this, the lighting of one or more of the buildings, or portions thereof, will be allotted to the various exhibitors of generating machinery to light and furnish electrical energy for operating motors, which will be used in large numbers for all kinds of service throughout the whole Exhibition, and the wires will be carried from each respective generating plant to the points designed for them to supply. The lines transmitting energy to the Electric Building, will supply current for every purpose required there. At first sight it might appear that the main portion of the electrical energy would be required in the Electric Building, but a moment's thought will show that this, however, is not the case, the proportion of power required for the exhibits being small in comparison with that to be distributed all over the Exhibition and grounds for lighting, power and traction purposes. For this reason, the amount of copper in the conductors connecting the Machinery Annex and the Electric Building, will not be abnormally excessive, although, of course, the extra expense would not have been entailed had the entire display been under one roof.

Strenuous efforts have been made from the outset to prevent a divided exhibit, and this newly suggested arrangement, should it be adopted, will practicably make the exhibit a twin one, the generating plant in the Machinery Annex being, of course, considered as a part of the electric exhibit.

AN ELECTRIC DISPATCH SYSTEM.

It has, for some time, seemed probable that one of the developments of the near future, in the way of transportation, would take the form of an electric dispatch system for carrying mails and certain classes of express matter at a high rate of speed between our principal commercial centres. Among the plans thus far proposed, perhaps the most unique is that of the Portelectric Company, of Boston, which may be regarded as a development, on electrical lines, of the pneumatic carrier system, which has long been in successful use in large cities for similar purposes. The report of Mr. Pope, which we reprint elsewhere, is, so far as we know, the first expert investigation of the actual merits of the portelectric scheme whose results have been made public, and the facts and figures given are of great interest. Mr. Pope's conclusions, though conservatively expressed, seem to leave little room to doubt the practicability of the system from a technical standpoint. It is true that the original cost of the plant must necessarily be greater than one in which traveling motors are employed, in accordance with ordinary practice, yet the absolute simplicity of the devices used, and the enhanced possibilities of speed which must result from the direct application of the propelling power to the carrier, are features whose importance may easily be overlooked at first sight. It certainly cannot be unreasonable to suppose that the factor of mechanical resistance in this apparatus can be reduced at least as low as that of an ordinary railway train, and granting this, Mr. Pope's predicted rate of speed of 150 miles per hour ought to be attained without difficulty, with the existing electrical appliances, at a very moderate cost for operating expenses.

We predict that the managers of the express and forwarding companies will be quick to see, in some such system as this, a possibility of enormously increasing the scope of their operations, for it needs but little consideration to show the practicability of a system of special delivery by which a letter or small package dispatched from New York could be delivered to the addressee in Boston within two hours, at a charge of ten cents or less, and yet leave a handsome profit to the carrier. That something of this kind will be done at an early day, and that such a system will divert a considerable share of the traffic that is now conducted by the mail and telegraph, there can be little reason to doubt.

The Meeting of the Electrical Engineers.

The annual meeting of the Institute last week was a success upon which the profession is to be greatly congratulated. In this issue we print such of the papers as are ready for publication—all of them excellent—and give a synopsis of the remarkable Tesla lecture. It will be noted also that the meeting did not lack in social success, for the reception at the Electric Club was an occasion long to be remembered. The Institute is happy, moreover, in its choice of Alexander Graham Bell for president. The office grows yearly in dignity and importance, and he will grace the leadership of a body of nearly 600 men in a profession of which his genius helped to create one of the leading branches.

New York Rapid Transit Plans.

It is now understood that the Rapid Transit Commission will report in favor of an 18 mile road, as nearly straight as possible, with two way tracks and two express, partly underground downtown, partly elevated, and partly viaduct, but with no surface track. With the express service, the total run will be made in 20 minutes. This road will be on the West Side all the way up. The main point of special interest to electrical engineers is that electric motors are preferred for the work, and that steam is not to be used. In this view of the situation, the Institute paper of Mr. F. J. Sprague is of unusual interest. It is a masterly effort anyhow, and shows how thoroughly Mr. Sprague has studied the problem. His determined fight for the adoption of electricity for New York's coming rapid transit now bids fair of early fruition. The mere rumor that the Commission has looked with interest at the operation of the "Bergmann" electric motor, shows that it is open to conviction as to the capacity of electricity to do the work.

Mr. Foster's Central Station articles will be continued next week.

THE PRACTICAL ASPECTS OF ELECTRIC WELDING.[1]

BY FREDERIC A. C. PERRINE, D. SC.

THE plant with which I have been intimately connected, though not one of the heaviest, is still one making a great number of successful welds in a day, and is one in which the joints are required to be of the highest character and are subjected to the severest tests. The first machine actually sold by the Welding Company was bought by the Roeblings. This was of the direct type, having a double winding on the armature, and the welding done on an apron immediately above the collector terminals of the heavy alternating coils; the pressure was applied by a handle regulated by the workman, the projection also being regulated by a scale stamped on the cam of the handle. Though considered crude, this machine did satisfactory work, often for 24 hours a day, and six days in the week, for about two years, having made about 370,000 splices in telegraph wire during its useful life.

After the automatic machines were brought to a reasonable perfection, we purchased a generator capable of welding up to ½ in. copper (40,000 watts), and installed one large transformer, and seven smaller ones of capacity from No. 4 B. & S. copper to No. 18 B. & S. These have been at the works something less than one year, and show a daily record of over 1,000 welds in copper and iron wire.

Messrs. Seward & Son, of New Haven, Conn., have at work a machine of somewhat universal character, its employment being principally in uniting Norway iron to Swedish steel, in such shapes as are required in carriage irons and fifth wheels. In this work the burr is removed by a drop hammer at the same heat by which the weld has been made.

The crescent tires of the hundreds of bicycles manufactured by the Pope Manufacturing Company, are welded and afterwards formed by dies at the same heat. The material is soft steel. These people also have a machine for brazing their small parts.

Besides using the electric welding machine for their telegraph wire, the Trenton Iron Company, of Trenton, N. J., have boldly attempted to make a weld in a wire rope to avoid the tedious, and, with their locked wire rope, impossible, operation of splicing. With the locked wire rope, which is itself but a single strand, the only successful method of joining opposite ends has been to fasten securely around each a cast-iron collar, and after abutting the ends in a welding machine, to cement the whole together and afterwards to break off the cast-iron collar, leaving the rope as a solid bar for about 2 in. at the weld.

Among the new solutions of old problems accomplished by the electric welding process, is that of the manufacture of spinning rings by the Hopedale Machine Company, of Hopedale, Mass. With a welding machine it is possible to form these little rings, about 2⅛ in. diameter, from a piece of bar iron, and after the burr has been reduced by a series of dies, to finish as before, with the result of a decreased cost, and an equally satisfactory product.

One of the largest and most complete plants at present in operation is that of the Studebaker Bros. Manufacturing Company, of South Bend, Ind. They have at present nine machines; one of them for steel axles up to 1⅛ in. square. After the weld is made it is quickly removed to a drop hammer, making about 300 blows a minute, then at the same heat the axle is set ready for the market. The test for these axles is to bend to 90° while hot, and then back to alignment. No instance has yet been reported of an axle breaking under this test, which is frequently made to insure perfect workmanship.

They have also two machines for welding large car tires, about 4 ins. wide and ¾ in. thick, and smaller sizes. The weld is made in the usual way and then quickly removed to a hammer, where, by vertical and side blows, the burr is quickly removed. One hammer will easily take care of two welders in constant operation. They also have one machine for small carriage tires, 1 in. x ¼ in., and smaller sizes. In this case the burr is removed by one blow of the hammer.

Probably the heaviest work done at present in electric welding, is that of the Johnson Rail Company, of Johnstown, Pa. As to their results in general, they say: "We would state that over a year ago we put in one welder for general work. The result of a year's use of the electric welder was, that we have not known one of the welds made by the method to fail, and we have closed contracts with the welding company for four 40,000 watt machines and two 89,000 watt machines, with the intention of adopting the method extensively in our works."

The hardest steel at present successfully worked by this process is the welding of band saws by the E. C. Atkins Company, of Indianapolis, Ind.; besides the regular work of making the joint in continuous band-saws, these people have ingeniously adopted this method for replacing broken teeth in finished saws.

Pipe welding is put in practice by the Pennsylvania Railroad Company, as well as by the Columbus Iron Works, Columbus, Ohio; Blymyer Ice Machine Company, Cincinnati, Ohio, and the Electric Pipe Bending Company, of Newark, N. J. This latter company is engaged principally in manufacturing long continuous coils for ice machines, blast furnace tuyeres, and radiators. With this machinery they not only weld extra heavy black pipe, but also electrically heat the pipe with a machine 20 in. between the clamps for the purpose of bending to desired shapes over pipe formers.

With continuously spiraled coils of pipe, under the present electrical methods, the coils are continuously heated in a fire, and the coiling is continuous while one length of pipe is welded at a time, the operation being to attach the welding machine to the end of the moving pipe, and while the forward portion is undergoing the process of bending, to weld on a new length, which will be accomplished in a sufficiently short time not to interfere with the coiling apparatus. In all this pipe welding the burr is beaten down by means of a pneumatic hammer, which is put in rapid motion by the act of closing it around the pipe.

Three types of machines of importance are soon to be in use for the purpose of our army and navy, and the early recognition of the importance of this method of manufacture, speaks well for the ingenuity of our government designers.

In the new wire-wound guns one of the most important specifications for the wire was that it should be readily jointed by the electric welding process, and in the Crozier gun, now constructing, the wire will be wound in one continuous piece under a constant and heavy strain. This wire is one-tenth in. square, with 180,000 lbs. breaking strength, and 100,000 lbs. elastic limit, tinned as lightly as possible. The gun is to be made by winding the wire over a steel tube and shrinking a ring over the whole, for the purpose of longitudinal strength; the welding process is simply the same as that described for round wire, and is reported as having given satisfactory results.

For the Charlestown Navy Yard there is about completed a machine for welding ship chains up to 2 in. diameter links. These links are formed in halves and fitted roughly to each other, the welds being made in both sides at once by the same heat, which can be regulated to force either side at the will of the operator. When completed, both welds are forged immediately in a die by the same hammer.

Electrically welded shells are made entirely of forged point, body and base, which may be finished to approximate dimensions, these requiring after welding a minimum amount of machining. The tests on these shells have resulted in a contract for a large number under a guarantee of the manufacturing company.

The electric welding process uses rather the method of the crucible than of the press, for although considerable pressures are applied during the operation, they are not beyond the limits of ordinary forging, and the essential difference is the greater heat available at the direct point where it is most needed, a heat which approaches and often reaches the melting point of the material. As the pressure is applied it is transmitted by the cold bar directly upon the softened metal and forces it to unite more readily. This view of the process brings us at once to some of the most important limitations; cast-iron, cast-steel, cast-copper, cast-brass, are not changed in their essential constitution, but are united by a weld having all the characteristics of the original bar. Now let us take a bar of rolled zinc or drawn copper and compare it with the cast metal. We find the crystals, formerly large, and widely separated, especially in the case of zinc, where often internal oxide stains are perceptible, now are broken into minute fragments, elongated and united so closely as to allow the greatest opportunity for the action of cohesion. Weld such a metal as this, and the joint where broken will immediately show a re-arrangement of the particles into larger and looser crystals similar to those of the unworked metal. By repeated fracture of the bar, you will be able to follow graduations of the action till it loses itself.

A weld of this character will give a sufficient tensile strength, but the brittleness of a coarsely crystalline material has returned. Whether such a joint is worthless is entirely a matter of circumstances. With small sections the action is not perceptible on account of the very small length heated, and also because bending, however short, does not subject the metal to so great a strain as is the case with larger sections. For a rod to be subjected to further drawing, rolling, or other like processes of manufacture, the weld is satisfactory, since the subsequent working reinstates the metal to its best condition, but for a wire to be considered a finished product, further manipulation is necessary. In view of this, the later machines for welding heavy copper have been provided with reheating clamps and light rapid hammers, by means of which the burr, after a slight trimming, can be reheated and forged; in special cases a further hammering cold is added. Though this produces a great improvement in the metal, it yet leaves a good deal to be desired where great strength and pliability are required. To produce this, a further upsetting of the metal throughout the whole heated space, and a subsequent forging will be necessary. This, up to the present time, has not been provided for, and presents a greater difficulty than is at first apparent, besides furnishing a new proof of the crystalline constitution of copper. On account of this characteristic, as is apparent on attempting upsetting in the welding machine, it offers, at a red heat capable of moving and re-arranging the particles, a resistance to compression so high, that three or four times the pressure necessary for welding will not have the slightest effect towards increasing the diameter or upsetting. With bronzes the further difficulty is encountered of red shortness between the molten temperature of the weld, and the malleable red temperature. That this should be so necessary and offer so many difficulties may seem strange, since the metal does not apparently exceed the temperature of ordinary annealing, and it must be that either the passage of the current by an extra disturbance helps to re-arrange the particles, or else the temperature is greater than we imagine from an observation. The latter explanation seems to me to be the more likely, since our ordinary observations are made on metals heated from an external source, and of which the surface is at the highest temperature. With the weld, however, the source of heat is internal, and the surface is undergoing a continual cooling from the external air.

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 20th, 1891.

Welds made in the higher carbon steels are at a similar disadvantage, and must be looked upon with disfavor unless provision for upsetting and forging hot is made.

This brings us to a point where the electric welding throws light upon the actual production and nature of burnt steel. By forcing the heat in welding, no matter if rapidly, this effect can be produced as thoroughly as by the means of a fire, while if the name "burnt" was an accurate description, and the iron and carbon oxidized, a sufficient time would be necessary for its penetration into the centre of a bar of metal. This agrees with and is a further confirmation of the most modern ideas about burnt metal, that it is a molecular re-arrangement, and by careful forging and heating the metal can be restored to its original state. In this case oxidation certainly does not take place, though the action may be similar to metamorphism in rocks; steel being at the present day looked upon as a mineral, a matrix of iron including minerals which are generally compounds of iron with carbon, silicon, sulphur, manganese or phophorus. Under this view there may be internal chemical re-arrangement at high temperature. With carbon we know this to be the case, but I take it as settled by electrical heating that the change is not necessarily an oxidation.

The welding of two different materials, such as iron and steel or malleable cast-iron, presents another difficulty and possible danger. When such a weld is broken we find that the pressure in the plastic slate has forced the iron over the steel or malleable, which has itself been merely slightly melted and cemented to the adjacent particles of the iron. This produces what might be called a reverse rivetting, the hot iron having been upset over the steel and enclosing it tightly, in the place of having been upset in a hole as in ordinary rivetting.

A STUDY OF AN OPEN COIL ARC DYNAMO.[1]

BY MILTON E. THOMPSON.

In carrying out this work no attempt has been made to determine the efficiency of the dynamo, or to determine an answer to the question, Is the machine well suited for arc lighting? The vast numbers of these dynamos in daily use in all parts of the world is a practical answer which must carry more weight than any which might be suggested by a theoretical study of the machine. The experimental work of this investigation was carried out under the direction of Prof. Nichols in the laboratories of Cornell University, during the past winter, by the writer, with the assistance of Mr. H. J. Hotchkiss and Mr. E. L. Morley, and due credit must be given to these gentlemen for any points of interest which may have been brought out by the investigation.

The object in view was to determine accurately, by taking instantaneous values throughout the revolution, the character of the external and internal currents and electromotive forces.

The capacity of the dynamo in question was about ten arc lamps of 1,200 c. p. In order to carry out this work it was necessary to build a special commutating device of a character somewhat similar to a number of others before used in the Cornell laboratories for taking instantaneous values of current and potential.[2]

Three sets of curves of exterior current and potential were taken with three different loads upon the machine, and three sets of curves of current and potential through a single coil were taken with the same loads. In order to keep the electromotive force as nearly constant as possible, and prevent variations while a set of observations were being taken, the machine was loaded with a German-silver resistance. The loads consisted of about 20, 50, and 80 ohms, respectively, and were equivalent to about three, six and ten arc lamps. The current for all loads was supposed to be practically constant, and an ammeter placed in the circuit showed but little variation from the normal current of 6.8 amperes. A condenser and ballistic galvanometer were used for making the measurements, and Fig. 1 shows a diagram of the connection of the dynamo and also of the measuring apparatus. Referring to the diagram, A is the armature, FF the field coils, M the regulator magnet, C the controller magnet, and *r* the carbon resistance used to prevent excessive sparking at the contacts *k*; P is the positive terminal of the machine and N the negative, B is the German silver resistance which constituted the load for the dynamo, and *t* is a resistance of about one ohm placed in the circuit to serve as a basis for the current measurements. LL and SS are the brushes of the dynamo, which bear against the three segments of the commutator, as shown in the diagram; D is a condenser, K a discharging key, and J a small spring switch; G is a ballistic galvanometer, through which the condenser was discharged, and T is a shunt box for regulating the throw of the galvanometer and bringing it within proper limits. From the negative terminal of the machine, N, runs a wire to the commutating device, *c s*, and from that to the switch, J. From the positive terminal, P, and the binding post, B, run wires to *f* and *g* of the switch, *fgh*, as shown. From *g* of this switch runs a wire to the discharging key, K.

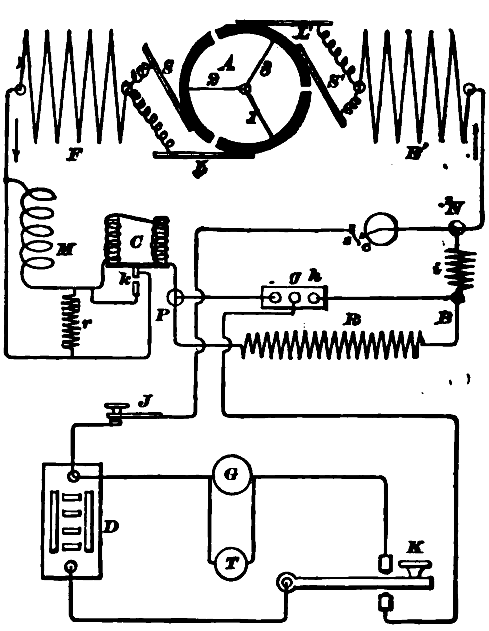

Fig. 1.

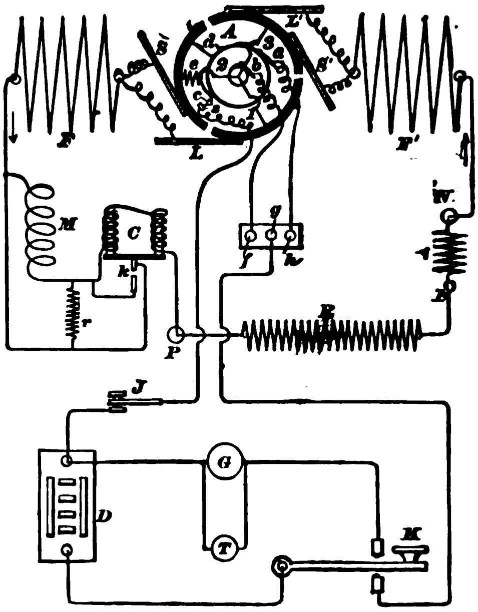

Fig. 2.

During these experiments the regulator was allowed to act just as in ordinary practice, but each load was constant and practically non-inductive. Three sets of curves of external current and potential were taken and the measurements were made in the following manner: The commutating device, C S, being secured in a fixed position, *f* and *g* were connected. The discharging key, K, being then depressed, switch J was then closed and in a few seconds the condenser became charged with the difference of potential existing between the terminals of the dynamo at the particular point of the revolution of the armature represented by the position of the commutating device. Switch J being then opened, the discharging key, K, was allowed to rise, and the condenser was thus discharged through the galvanometer, G, causing a deflection which was duly noted. The connections of the switch, *fgh*, were then changed so that *g* and *h* were joined, and in this way the condenser was charged with the difference of potential existing between the points B and N of the external circuit, at the same point of the revolution as the first reading. The condenser was then discharged through the galvanometer and the deflection noted as before.

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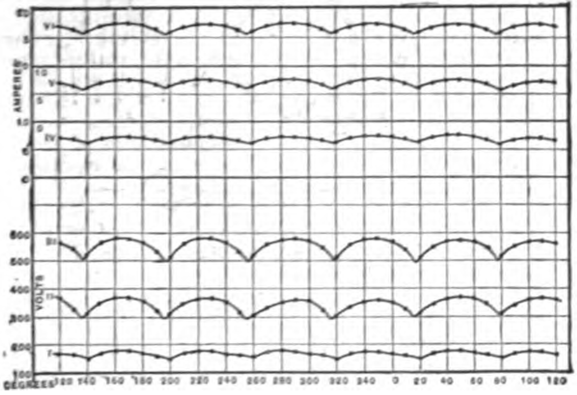
[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 21st, 1891.

[2] TRANSACTIONS, Am. Inst. Elec. Eng., vol. vii, p. 3.

Fig. 3.



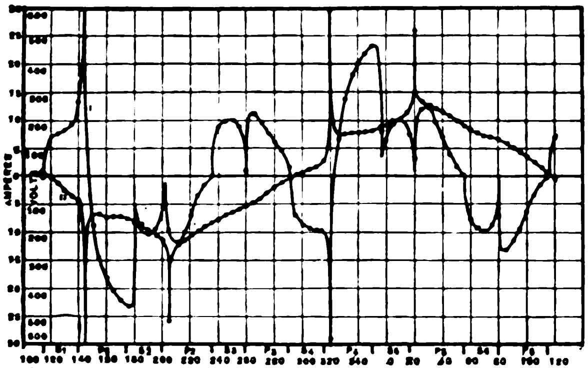


Fig. 4.

After moving the contact spring, *s*, forward ten degrees, the measurements just described were repeated, and so on until the contact had been moved entirely around the circle.

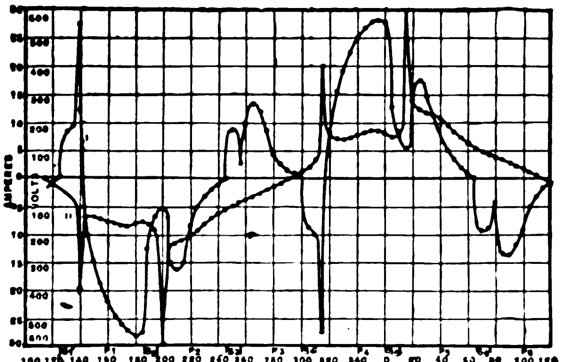


Fig 5.

The condenser and galvanometer being properly calibrated, it was an easy matter to calculate from the data obtained as above, the difference of potential between the terminals P and N, and between B and N, at 36 points of the revolution of the armature. The resistance between B and N being known, the current was readily determined from the fall of potential. The results of these measurements are shown graphically in Fig. 3, and will be referred to later.

After taking curves of the exterior potential and current, the apparatus was arranged for measuring the potential and current in a single coil of the armature. Coil number 2 was selected as likely to present results nearest the average of all three of the coils, and the apparatus was arranged as shown in Fig. 2. The circuit of the dynamo and its loads were exactly as for the first measurements, and the connections of the measuring instruments were as shown in the diagram.

Readings were taken at distances of five degrees apart all around the revolution and the results are plotted out in Figs. 4, 5 and 6, three curves at three different loads being taken as before.

Turning now to the results obtained in Fig. 3, curve I represents the difference of potential at the terminals of the dynamo throughout the revolution under a light load, and curve IV is the corresponding current. Curve II is the potential for medium load and curve V the corresponding current, while curves III and VI represent the potential and current at full load. It will be noticed that the curves for medium and full load are practically alike, while the current for light load differs slightly in its character and is less symmetrical, and its minimum points occur slightly later than in the other curves. The curves of current and potential are practically alike, as might be expected, since the self-induction of the external circuit was little or nothing. The curves are all of them about such as would result from a closed coil armature with a six part commutator. These curves show that the external current is continuous and much steadier and more uniform than is usually supposed.

Fig. 6.

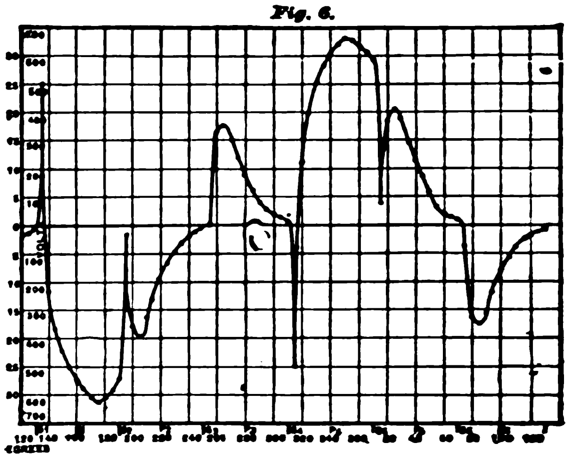
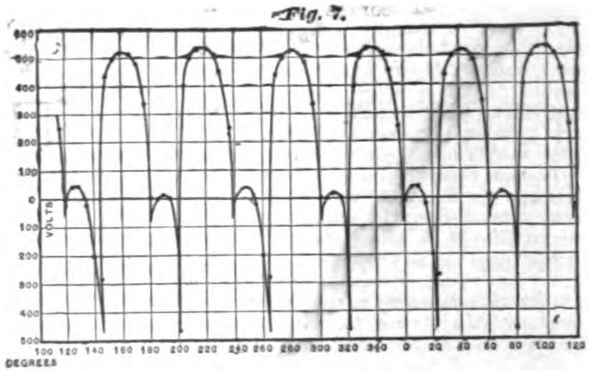


Fig. 7.



Referring to Fig. 4, we find that the state of affairs in a single coil is quite different from that at the terminals of the dynamo. Curve I represents the difference of potential at the ends of the coil throughout the revolution, and curve II is the current in the same coil during the revolution. The curves shown in Fig. 4 were taken with a light load. Figs. 5 and 6 show curves taken with medium and with full loads. For some unknown reason it was found impossible to get accurate readings for the current at full load, and so no current curve is given in Fig. 6. It is probable, though, from the similarity of the current curves at light load and at medium load, that the current for full load differed very little from the other two.

It will be noticed that at all loads the potential changes sign no less than six times during the revolution and falls to zero, or almost to it, as often as twelve times, while the current reverses but twice during the revolution and for the most part goes through very gradual changes. At the bottoms of the figures are lines of spaces showing the positions of the armature during the part of the revolution represented by the curves above them. s_1, s_2, s_3, etc., are the periods of short circuit and p_1, p_2, p_3, etc., are the periods during which two coils are usually supposed to be in parallel with each other and in series with the third coil. There are six periods of each kind in the course of each revolution. Figs. 10, 14 and 18 represent the relative positions of commutator and brushes at the three different loads during the parts of revolution shown at s_1. For the light load this period is about 25°; for the medium load about 10°, and for full load not more than 1°. The periods shown are not the *actual*, but the *apparent*, periods of short circuit as it would seem to be from the positions of the commutator and brushes. The *actual* periods of short circuit are somewhat longer, owing to the conductivity of the spark, and last until the spark is blown out. The exact point of the revolution, represented by Figs. 10, 14 and 18, is the point 130°, as marked below the curves. Figs. 11, 15 and 19 represent the positions of the brushes and commutator for the parallel periods p_1, or, to give the exact position shown, 160°. Figs. 12, 16 and 20 represent the second short circuit period, s_2, or 190°, and Figs. 13, 17 and 21 show the second periods of parallelism, p_2, or 220°. In all of these figures the relative positions of the coils and poles of the dynamo are also shown, the coils being numbered 1, 2, 3, just as they are on the dynamo. During the entire period represented by each four figures as above, the armature has turned through 120°, or one-third of the revolution, and if we now consider the position of coil 2 changed to that of coil 1 in each figure, our figures will then represent the next third of the revolution. If coil 3 is supposed to occupy the position of coil 1, we shall then have the remaining third of the revolution.

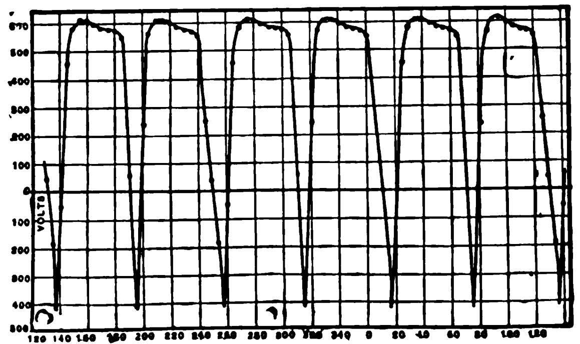
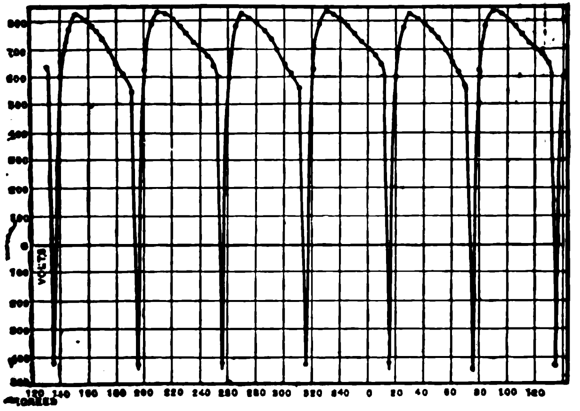


Fig. 8.

It will be noticed that the more sudden and violent changes of potential occur just as the spark is forming and being broken at the front end of the commutator bar.

In examining these curves of potential it should be remembered that they represent the *difference* of *potential* at the ends of the coil and *not* the E. M. F. developed in the coil during the revolution.

Fig. 9.



It will be noticed that the direction of the currents in the various coils for the so-called periods of parallelism and short circuit is quite different from what would be naturally expected and from what has been supposed to be the case in most of the descriptions of the action of this machine. It will be seen that there is no instant during the so-called parallel period when coils 1 and 3 are in parallel and that the *actual* parallelism does not occur until after the beginning of the period of short circuit. In the case of medium and full loads, however, it occurs at from 10° to 20° before the period of short circuit. Another point worthy of notice is, that at the first instant of short circuit, when the commutator bar just touches the following brush, there is no sudden increase of current, as would be naturally expected, but the current in the short circuited coils slowly and gradually increases until the short circuit is broken by the blowing out of the spark, at which instant the current is a maximum in the coil whose commutator bar is opposite the sparking point, and in the other two coils it is about the same as the normal external current.

In Figs. 7, 8 and 9 are shown curves of potential at the brushes, at the three different loads. These curves were obtained from the potential curves of Figs. 4, 5 and 6, by adding together the potentials of the three coils according to their relative positions, and thus obtaining the potential at the brushes. It will be noticed that at all loads the curves fall below zero six times during each revolution, and that the difference in area, and consequent effective E. M. F., is obtained more by the widening out of the curves than by increase in height. This is what we ought to expect from the change in duration of the short circuit periods. A comparison of these three curves of potential at the brushes, with the three curves of potential at the terminals of the dynamo will give one a good idea of the remarkable steadying power which magnets such as the fields of this dynamo, exert upon an intermittent current. No further explanation is needed of the fact that this dynamo will not work as a separately excited machine. The whole set of curves will serve to illustrate some of the very remarkable effects of armature and field reactions and any one sufficiently interested to make a detailed study of them might possibly succeed in bringing out a number of curious and interesting, if not useful, results.

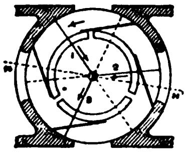


Fig. 10.

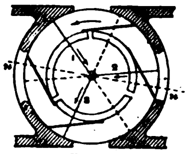


Fig. 14.

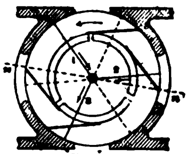


Fig. 18.

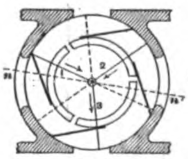


Fig. 11.

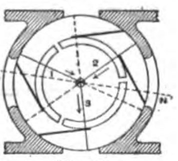


Fig. 15.

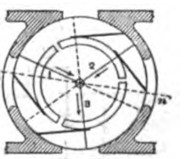


Fig. 19.

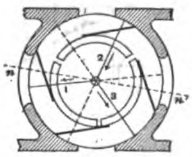


Fig. 12.

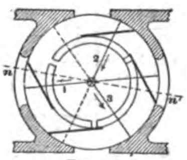


Fig. 16.

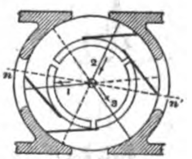


Fig. 20.

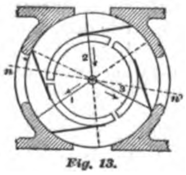


Fig. 13.

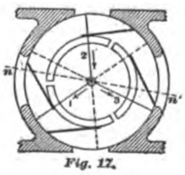


Fig. 17.

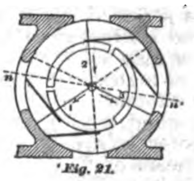


Fig. 21.

AN ALTERNATE CURRENT POTENTIOMETER.[1]

BY GEORGE S. MOLER.

THIS device is designed for the purpose of determining what values of the potentials of alternating currents will produce given effects, and is intended to be used mainly in calibrating alternate current voltmeters. It may also be used as a voltmeter, applying it directly to the alternate current to be measured. By means of this apparatus we may determine whether the instrument which is being calibrated changes its reading for other rates of alternations. This is shown by comparing the calibration curves obtained by using widely different rates of alternations.

The instrument, briefly described, is as follows: An incandescent lamp is so arranged and connected that it can be switched back and forth from the terminals of an alternating current line to those of a direct current line, which can be altered in voltage till the lamp glows with the same intensity when fed by either line. Then, while switched into the direct current line, the voltage of that line is measured by a direct current standard voltmeter or potential instrument, and the voltage so read is equivalent to that of the alternating current, which produces the same effect in the lamp. The switch is so constructed that it snaps back and forth, making the change of connection so quickly that the slightest change of intensity of the light can be easily detected. The lamp has a blackened hood with an opening in one side through which it is viewed while the sliding resistance is being adjusted. This enables the observer to make a much closer setting than otherwise. A very close setting may also be made by observing the slight reflection of the light from the blackened surface of the hood.

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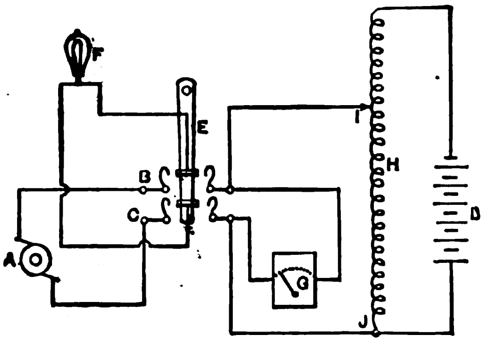
[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 21st, 1891.

The lamp and switch are arranged and connected in the following manner: Referring to the diagram, A is the alternate current dynamo, or line, of which we wish to determine the effective difference of potential in volts between its two terminals, B and C; D is a storage battery or direct current dynamo of higher voltage than the alternate current to be measured. A switch, E, made to snap back and forth by means of a stiff spring, changes the incandescent lamp F, from the alternating current to the direct current and vice versa. By connecting the two extremities of a resistance, H, to the battery, D, and sliding the contact point, I, such a place can be found that the intensity of illumination will be the same for both currents. After the contact I is adjusted, the standard voltmeter, G, is read while the direct current is flowing through the lamp, and this voltage is taken as the equivalent voltage of the alternate current.



MOLER'S ALTERNATE CURRENT POTENTIOMETER.

A series of lamps of different voltages affords a greater range to the instrument than could be obtained with one lamp only. These may all be connected to the switch, and, beginning at the one of highest voltage, one after another may be tried till the best one is found. For higher voltages than the highest voltage lamp will stand, a number of lamps may be used in series, and the fall of potential for all, or for each individual lamp, can be measured by means of its voltmeter. The resistance H, must necessarily be great enough in amount so that only a small current will be allowed to flow through it, so that the comsumption of energy will be small.

Instead of having the switch and lamp connected in a shunt line to the resistance H, it may be connected in series with H, which must then be arranged so that it can be varied in amount. If a source of constant potential large enough in amount is available, the apparatus may be used for a voltmeter for direct or alternating currents. To use it in this manner, we calibrate the apparatus to find the potentials at the terminals of the lamp for different positions of the contact points I and J, and construct a curve, using the positions of I and J as abcissæ and the differences of potential of those points as ordinates. Then, when using the apparatus as a voltmeter, we read the values from this curve instead of from a voltmeter connected to the switch.

Upon this instrument readings could be estimated to one-tenth of a mm., giving volts to the second decimal place. The accompanying table of results were the first part of the first set taken without any preliminary practice. From this it will be evident that the adjustment of the light can be made to within one-tenth of a volt.

LEFT CONTACT.	RIGHT CONTACT.	
VOLTS.	VOLTS.	DIFF.
29.95	29.85	+.1
29.62	26.60	+.02
33.07	33.11	—.04
37.56	37.55	+.01
42.52	42.60	—.08
60.95	60.90	+.05
74.68	74.72	—.04

A NEW GRAPHICAL METHOD OF CALCULATING LEADS FOR WIRING.[1]

BY CARL HERING.

THE following suggestions of a graphical method is an attempt to reduce this work to what might be called "machine methods," by substituting for the usual figuring, a simple graphical device which requires no figuring at all and which is, at the same time, universal in its application, as it is adapted equally well for any of the many different lamps in the market to-day.

Makers and users of one particular lamp can readily calculate a wiring table for that lamp, for each of a few of the usual losses in the leads, and such tables are often quite convenient for those particular conditions; but it is evident that they are limited to those fixed conditions. As long as there are lamps of such different amperage and voltage, it would hardly be practicable to make a universal set of tables, especially when the currents which the lamps take are greater than what is claimed for them. Graphical methods, therefore, suggest themselves, for in these the size of the diagrams does not increase nearly as rapidly for an increased scope as the number of tables would. Graphical methods have been devised to replace the tables, but they have not been satisfactory for various reasons.

The present method is an improvement on the one described by the writer in THE ELECTRICAL ENGINEER of Jan., 1887. The general principle may be laid down that for any formula containing three variable quantities, one of which is the product or the quotient of the other two, the "curves" representing their relative values may always be represented by a series of straight diagonal lines drawn through the centre or zero point. Such a set of lines will therefore enable one to make any calculations graphically for that formula. For instance, horse power is equal to volts multiplied by amperes; the constant 746 does not concern us at present. A series of diagonal lines properly spaced will therefore give directly either the horse power, the volts or the amperes, when the other two are given. The curves may also be made hyperbolas, but it is evidently absurd to draw hyperbolas when straight lines answer just as well and are even more accurate, as they can be laid off and drawn with great precision. Notwithstanding this, such diagrams are often published as hyperbolas.

Now, the general formula for wiring is as follows:

$$\text{Cross-section} = \frac{\text{current for one lamp} \times \text{number of lamps} \times \text{distance} \times \text{constant}}{\text{loss in volts.}}$$

containing six quantities, only one of which is always constant, being equal to twice the mil foot resistance of copper, if the cross-section is in circular mils. For instance, for any one make of lamp the current per lamp is a constant, and may therefore be combined with the other constant as one; if, furthermore, the number of lamps and distance be multiplied together mentally and then used as one quantity, lamp feet, there are then only three variable quantities to the formula, and calculations can then be made by one set of diagonals. This will give the diagram mentioned in the early part of this paper. But a universal diagram must be equally well applicable to any lamp; and as graphical calculations are so much simpler, more rapid, and less liable to error than arithmetical ones, it is preferable to multiply the lamps by the feet graphically also. Both of these may be accomplished by splitting up this formula into smaller ones, each of which contains no more than three variable quantities. Each formula can then be calculated separately by a simple diagram, as described, thus permitting the whole formula to be calculated graphically.

To do this, let the first diagram perform the calculation,

$$x = \frac{\text{current for one lamp}}{\text{loss in volts,}}$$

in which x is a mere auxiliary quantity. Let a second similar diagram perform the next calculation:

$$y = x \times \text{number of lamps};$$

and a third diagram the final calculation:

$$\text{Cross-section} = y \times \text{distance}.$$

The constant may be combined with any one of these; it is immaterial which one. This triple calculation may at first seem to complicate matters on account of the new quantities, x and y. These, however, are easily eliminated by the simple device of placing the three diagrams together, side by side, in such a position that the two x scales coincide, and similarly the two y scales.

In the accompanying diagram the formula just given is represented graphically as described. It will be seen to consist of three right angles, each with its set of diagonals and a common centre. Each two right angles have one side in common which represent the quantities x and y, and which thereby drop out of consideration. The lower left hand diagonals represent *loss* in

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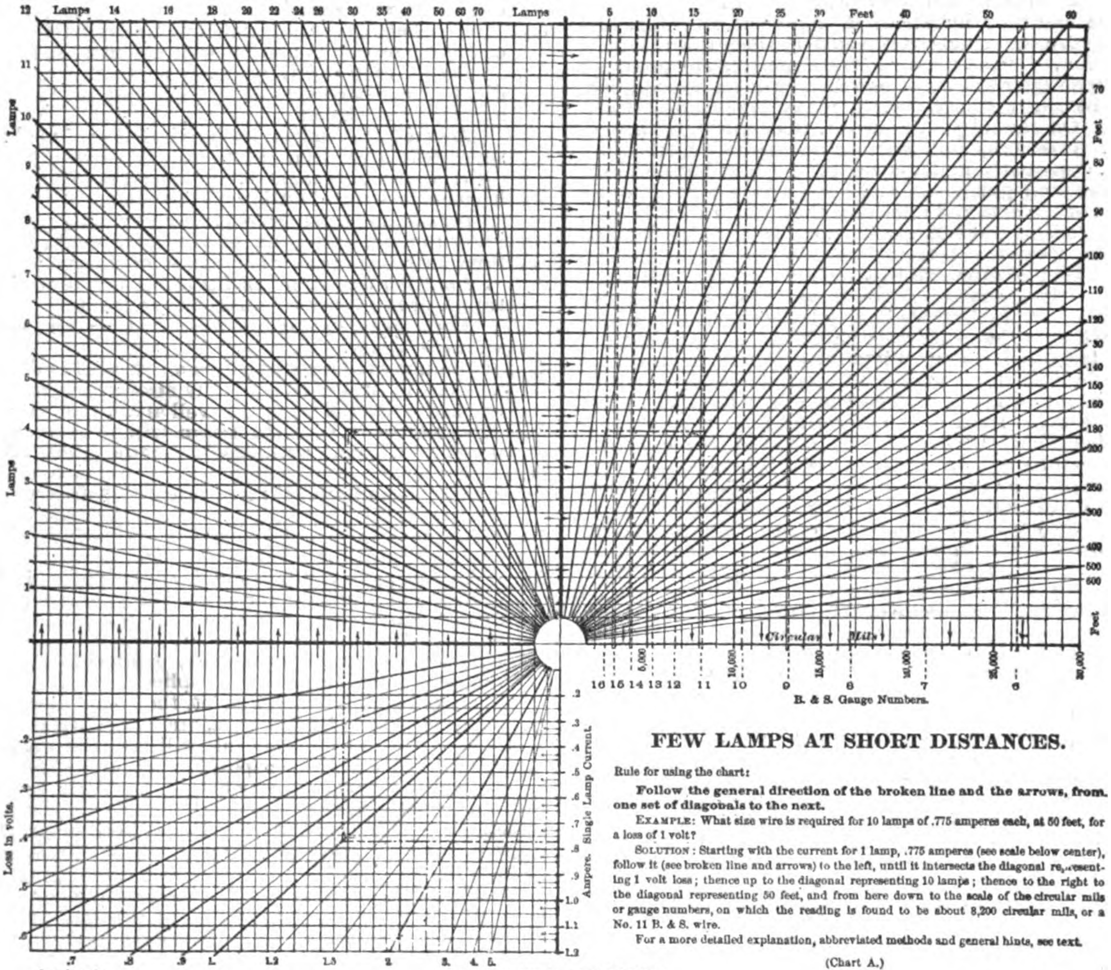
[1] An abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 20th, 1891.

volts, the upper left hand, *number of lamps*, and the upper right hand, *distances*. The remaining two of the five variables are represented by the starting scale vertically below the centre, which represents the *amperage of a single lamp*, and the last scale, to the right of the centre, which represents the final result, namely, the *cross-section*. The constant is included in any one of these three sets.

To perform the graphical calculations, simply follow from one scale to the next on the cross-lined brackground up to the last scale, the cross-sections, which is the final result sought for. An example is worked out and illustrated by the broken line on the diagram. Starting first with the amperage of the particular lamp, .775, on the first scale, follow to the left (see the broken line) to its intersection with the required volt diagonal, 1.0 volt; thence up to the next diagonals, the lamps, 10 lamps; thence to the right to the feet diagonals, 50 feet; thence down to the scale of cross-sections, where the reading is about 8,200 circular mils, or about a No. 11 B. and S. wire; the whole operation requiring about as much time as it would take to start the arithmetical calculations.

The relative disposition of the scales is also of importance in such a diagram. For instance, the amperage of the lamp is generally the same for a great many computations; it has therefore been made the first scale, so that it can be eliminated from all those computations by drawing a horizontal line, say in red ink, through this value and then starting all the calculations from this line, thus saving that first part of the work. Next to the amperage of the lamp, the loss in volts is often the same for many calculations; the volt scale has therefore been made the second one, so that it also may be cut out of these calculations. To eliminate this part, draw a vertical red line through the intersection of the ampere and the volt lines. All such calculations are then started directly from the intersection of this line with the lamp scales. Finally, by the dotted lines drawn through the last scale, as shown, representing the cross-sections of the standard wire gauge sizes, the last part of the work is also saved. The only operation left to be performed, therefore, is to follow a horizontal line from the number of lamps to the number of feet; it would hardly be possible to have it simpler. As the majority of calculations are made for the same amperage of loss, this represents the most frequent conditions under which the diagrams would be used.

The range of such a diagram can evidently be made very great by having several sets of numbers on the scales; each set being, say, ten times larger or smaller than the other, the position of the diagonals will remain the same. By an accidental coincidence the position of the dotted lines representing the B. and S. gauge numbers, will also remain very nearly the same for different scales of circular mils, even though they represent different gauge numbers. Furthermore, lamps and feet are interchangeable on the diagram. Although the same diagram may have several different sets of numbers, it is probably preferable to have a separate diagram for each set. A set of three diagrams, of which the accompanying is the first one, will probably cover the usual ranges. For motor currents the same diagrams may be used, by assuming that the current represents that number of one-ampere lamps.



FEW LAMPS AT SHORT DISTANCES.

Rule for using the chart:

Follow the general direction of the broken line and the arrows, from one set of diagonals to the next.

Example: What size wire is required for 10 lamps of .775 amperes each, at 50 feet, for a loss of 1 volt?

Solution: Starting with the current for 1 lamp, .775 amperes (see scale below center), follow it (see broken line and arrows) to the left, until it intersects the diagonal representing 1 volt loss; thence up to the diagonal representing 10 lamps; thence to the right to the diagonal representing 50 feet, and from here down to the scale of the circular mils or gauge numbers, on which the reading is found to be about 8,200 circular mils, or a No. 11 B. & S. wire.

For a more detailed explanation, abbreviated methods and general hints, see text.

(Chart A.)

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HERING'S WIRING CHART.

VISIT TO THE CROCKER-WHEELER FACTORY.

The members of the Institute met at the Crocker-Wheeler Company's, at 9:30 o'clock, on May 21, and were shown through the shops. They saw the manufacture of electric motors as carried on by that company, and as described and illustrated in last week's issue of THE ELECTRICAL ENGINEER. A table holding eight motors, ranging in size from 1/6 to 1 h. p., all exactly of the same type, made quite a harmonious exhibit as illustrative of gradations in size. One of the novelties, however, which pleased the members of the Institute very much was the new arc motor with perfected governor. A Silsby 100 gallon per hour rotary pump, connected to a ¼ h. p. motor, and one combination pump of the same make, coupled direct to the armature of the motor, worked to perfection. The self-governing device which this company has for pumping water to the tops of houses, and automatically shutting off the circuit when the tank is full, was shown on one 150 gallon, Gould triplex pump connected to a ½ h. p. motor, and one 225 gallon per hour Gould pump connected to a 1/6 h. p. motor. A La Rue combination exhaust air blower fan was shown, mounted on the window sill. This combination is very compact.

CONSIDERATIONS WHICH SHOULD GOVERN THE SELECTION OF A RAPID TRANSIT SYSTEM.[1]

BY FRANK J. SPRAGUE.

It has been but a short time since the Legislature of New York, in response to public demands as voiced by the press, in petitions, and through the personal efforts of the representatives of this city, enacted a rapid transit law to create a Board of Commissioners with large powers for the purpose of determining rapid transit routes for this city.

During the past three months the Commission appointed under this law has held numerous public meetings, at which various systems have been proposed. These meetings are now practically at an end, and it is currently reported that a portion at least of the rapid transit routes have been determined. Since this subject of transit is one which has a most important bearing upon present and future New York, and is one in which the public has vital interest, it is eminently proper that so much of the Commission's deliberation as have through its chairman been reported should be the subject of public comment and critical analysis.

The public is naturally impatient in demanding results, and has been unduly free in criticisms directed against the members of the Commission, often assigning to them motives and proposed actions based upon their known or assumed business associations, which criticisms are undoubtedly, in many instances at least, wholly unjust. On one subject, however, that public is particularly sensitive. It sees the daily encroachments made by the Manhattan system, apparently under cover of the law but in direct violation of its express provisions, and has no reason to be other than suspicious of the acts and intents of that corporation.

Probably there is no more flagrant example of this than the present work being carried on from 59th street up, on the Harlem division. Already the cross girders connecting the two track structures for nearly the entire section from 72d street, to above 155th street, have been replaced by heavy lattice girders on which are supported either lattice or plate longitudinal girders, for a third track. On a large portion of this section the third track has already been laid. The method adopted seems to be the construction of a switch connection of moderate length, the connection of which with the main track is eliminated as soon as another adjoining section is completed. The rapid transit law expressly forbids the laying of any third track except with the concurrence of every member of the Commission, and since no steps are taken to prevent this construction, and since it seems likely that the Manhattan Company would not go to the expense of making this change without some assurance that it would have the necessary permission granted to it, or that it would not be interfered with, the public naturally ask, What is the influence possessed by this company? How far does it dominate the Rapid Transit Commission?

I will not undertake to answer these questions, but it should be remembered that this Commission is composed of five men whose selection at the time made met with general commendation; that they are each men of independent fortune; each is distinguished in certain independent business lines, and all are recognized as men of public spirit, capacity and probity. They are, moreover, armed with great authority, can be safely said to be conscious of the gravity of their decision, and intent on giving to it most serious and weighty consideration.

It is then fair to accord to them an honest desire to make a determination of this question of such character as will, both in the present and in the future, prove to be undeniably the best, reserving the right of criticism both of result and motives until after the announcement of a decision which should not be unduly hurried.

Before considering the current reports of the Commission's deliberations, a general review of the subject may be advisable. There are two classes of people who are concerned in the final decision made, the public and the capitalists. In order to satisfy as far as possible the demands of both, some of which are common, it is well to examine them separately.

To accommodate the public, it is necessary to:

1st. Supply present demands by following as nearly as possible the most important existing arteries of travel. An express train on the banks of the Hudson would be of little use to Broadway.

2nd. Provide for those future lines of traffic which, other things being equal, will most naturally be formed.

3rd. Make the most numerous and convenient connections for existing and projected local and suburban transit lines in directions other than those followed by the main system.

4th. Interfere least with changes in present buildings, or the erection of future ones. In no city in the world is this change more pronounced or continuous.

5th. Cause the least disturbance to, or weakness of, foundations, present or future, and unnecessary displacement of service pipes, whether steam, gas, electric, air or sewer.

6th. Avoid disfigurement of streets and unnecessary appropriation of them.

7th. Inflict the least damage to property, either during construction or afterwards in operation.

8th. Provide the highest express and way speeds, each on independent tracks.

9th. Attain this last with the least liability of derailment or other accident.

10th. Provide the easiest access to stations, taking of all trains from one station, transfer from way to express trains and vice versa, from up to down trains, or to cross-town trains, or other intersecting lines.

11th. Finally, it must be built as quickly as possible, and should possess great flexibility.

To attract capital, the system:

1st. Should afford a reasonable and certain return on the money invested in the near, and a greater return in the remote future.

To do this the road must attract passengers, which it will do by following the main arteries of travel, and by affording increased speed, with increased comfort and safety.

2nd. Must be built economically, and as cheaply as possible consistent with sound plans for future growth.

3rd. The cost should be calculable with reasonable accuracy. This cost is comprised in a number of elements as follows:

Preparation of Way, such as tearing down buildings, digging up streets, moving pipe systems, altering sewers, sinking of shafts, etc.

Actual Construction, such as building of viaducts, erecting superstructures, driving tunnels, laying road-beds.

Temporary Damage to, and blocking of public and private business and travel during construction.

Permanant Damage to Property, whether caused by proximity to road, noise, dirt, or vibration, weakening of foundations, or interference with future buildings.

Building Space Taken Up, either by the roadway, moving trains, or necessary clearance above them.

Equipment of Rolling Stock, less with steam, greater with electricity.

4th. Should be such a construction as to make additional tracks possible, if future demands should warrant it, whether such tracks be parallel to, or intersect with, the main system.

5th. The process of construction should be hampered as little as possible by injunctions, or legal complications of any kind.

6th. The plan of construction should be such as can be most readily begun, most rapidly carried forward, and most quickly enable the road to become a dividend earner.

7th. The franchise granted should be secure from unjust restriction and future interference.

8th. The raising of capital should not be made difficult by the granting of privileges for extension to existing corporations, of such character as to make their competition in the same field. An extension of the "elevated" up the Boulevard would have its influence on any other system proposed for the same route.

That the demands of both public and capitalists as here outlined should be as far as possible met, goes without saying.

Up to very recently, from the reports of the proceedings of the public hearings which have been held, and the statements which have been made from time to time in the daily press, the Commission seems to have:

Listened publicly and with patience to all plans of routes and construction submitted for their consideration, whether good, bad or indifferent.

Selected from these plans the limited number which, during the past few years, have more or less engaged public attention, and have at least the merit of financial backing, the record of operation elsewhere, or the promise in a more or less satisfactory degree of fulfilling the demands of a rapid transit system.

Examined privately some of the representatives of some of the leading systems.

Not publicly discussed the question of motive power, but are privately investigating it, and have not yet determined what it shall be.

Expressed serious doubts as to the availability of electricity as a motive power.

Determined that, unless electricity is used, no form of tunnel, shallow, individual or deep, shall be used.

Making a personal investigation of the topography of the city with a view of determining its present needs and future lines of growth.

Determined to first lay out a West Side route.

Are attempting the coincident determination of motive power and route.

Are much concerned as to property damages.

Such, as I say, until very recently, seems to have been the attitude of the Commission.

About a week ago, however, when the public had received the impression that it had about reached a conclusion to at least a portion of its labors, application was made by the Manhattan Company for extensions covering some 18 miles of street. The character of the proposed construction, the routes demanded, are now matter of record.

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[1] A paper read at the General Meeting of the American Institute of Electrical Engineers, May 21st, 1891.

It is but natural that the delays in submitting a route after the Chairman of the Commission had announced that it was about ready to do so, being followed by an elaborate presentation by the Manhattan Company of the plans for its proposed extension, which plans have taken a long time to prepare, preceded as this presentation was by an explicit declaration on the part of officers of this corporation that it contemplated no more extensions, naturally caused a feeling of distrust and uneasiness, and was followed by suggestions of possible bad faith on the part of the Commission, and this is no less annoying and disturbing because of its inherent improbability.

Why this action of the Manhattan Company excites this feeling is easily explained.

The portion of its scheme which most vitally concerns the city of New York is the proposed extension of the system from 33rd street up Broadway, through the Boulevard to 170th street, and its continuation. This is simply an iniquitous proposal—no other term can be applied to it, and if granted by the Commission, no matter with what restrictions, it will prove a vital blow for all real rapid transit in New York city in the life of this generation.

Let us see what will be the result of such an extension. That it would be built by the Manhattan Company if granted the right is undoubtedly true; that it would prove a profitable enterprise, is equally true; that it might be used for a repetition of the methods of financiering which characterized the consolidation of the elevated roads into the Manhattan system need not be doubted; that it will enhance the value of the property of that corporation needs no argument, but

What will it do to satisfy the needs of those who to-day use the elevated railroads?

How will it affect the well-being of this city?

With what sacrifice of its best interests would these schemes be carried out?

It is hardly necessary to point out that public spirit, civic pride or any feeling in fact, save the most sordid one, enters into the calculations of the Manhattan Corporation. Its spirit is much the same as that which prevails most unfortunately in a large portion of our city government.

It is well to recollect that some of the same men who have earned lasting condemnation of the public by their advocacy, some time since, of an elevated steel structure on Broadway, below 33d street, have again come to the front in support of the Broadway extension above 33d street.

The former scheme was for the time defeated. It has not been given up, but the basis of attack has been changed from lower to upper Broadway. Every capitalist knows the great value of a road of almost any character which can be allowed to follow this great artery of travel. Grant a franchise for the length of Broadway and the Boulevard, and there will be some interesting bidding for its control. The history of the Broadway surface road and the character of the street are in evidence. Hence, the ultimate object of this corporation is a line for the whole of Broadway.

How does it propose to get it? Defeated for a time in its assault on the lower portion, it has for months been getting the consent of property owners along the upper Boulevard, who, seeing a prospective rise in the value of their property, and careless of, or indifferent to, the real welfare of the city, and ignorant of systems save those presented by the Manhattan Company, have in many cases agreed to make no claim for damages in case an elevated structure is put up. Armed with these consents and practically assured of the consent of a city government, noted for its venality, anxious to add a heavily paying extension to its system, with lower Broadway as an objective point, and intent on defeating the raising of capital for any other system if reported, it now seeks the consent of the Rapid Transit Commission for this extension.

Consents thus sought, and in many cases obtained, ought not to weigh as an argument in favor of this extension, because the needs of the West Side property owners can be equally well served by another method of construction. That there is some explicit or tacit understanding with some of the city authorities seems evidenced by the continuance in its present disgraceful condition of the upper Boulevard, a street which was laid out for, and can be made to be, one of the finest in the world.

Let us suppose for a moment that the Commission so far prostituted its powers as to grant this extension, and it is built—What would be the result? It should be borne in mind that the traffic of the present Harlem division of the elevated road above 59th street, is mainly the growth of the past seven or eight years. It is a traffic created on account of the building which has taken place during that period. The Boulevard extension would not seriously divert travel from the present Harlem division. It would add nearly double that mileage to the present elevated system, and would build up a traffic of its own. It is safe to say, that in less than a single decade the travel on this extension would be greater than now exists on the Harlem division, while the travel on this latter would be in no wise lessened.

There would follow a congestion of traffic at, and below, 33d street, which cannot be realized, and this is precisely the result wanted by the Manhattan Company. It is impossible by any practical change in the Sixth avenue division to take care of this increased traffic, and the only outlet for it would be an extension of the road down Broadway.

Grant then the Boulevard extension for the Manhattan Company, and within 12 months after the first train has run over that extension, the necessary steps will be taken by this same corporation for the extension of the Boulevard line down Broadway from 33d street, and they will get it. There is no avoiding this conclusion.

If present public opinion will permit an extension of this system above 33d street, on Broadway and the Boulevard, for the benefit of the Manhattan Company and the West Side property owners, with the certain resulting congestion of traffic on that section of the present road, which vitally concerns all citizens, then it will in sheer desperation be compelled to acquiesce in the subsequent demand.

If to-day an intelligent and respected commission, made up of men presumably fairly representing the intelligence and public spirit of this community, cannot be relied upon to prevent the appropriation of one of the finest boulevards possessed by any city, forming the extension of one of the greatest business streets in the world, and the debauch of all real public interests by saddling upon this city the extension demanded, then it is hopeless to expect any future commission to withstand the pressure which would be put upon it.

If then it would save lower Broadway, it must protect upper Broadway. The system it adopts must be independent of, not dependent upon, the Manhattan system The rights of the West Side property owners must not be allowed to override those of the rest of the people in New York. Their interests can be better served by some other system which would give real rapid transit and leave Broadway and the Boulevard uninjured, nor should the property owners of this section be themselves content with a higher speed above 59th street, and a lower speed below 33rd.

The question is not, How can the promotors of the Manhattan system find a most remunerative opportunity for the investment of additional capital, or How can they obtain the largest return with the least expenditure? The public of New York is most concerned, possibly selfishly, with plans by which it can best serve its own interests, the real interests of a great city, one fast outgrowing the iron bound vision of the Manhattan corporation.

Fortunately it rests with any one man in this Commission to prevent any extension of the elevated system, and I think we can safely assume that no such extension will be granted except such as is consistent with the best interests of this city. I would not take the position for one moment that no rights should be granted to the elevated railway other than they now possess. I would say let its service be improved as much as is possible, but such improvement of service should not be coupled with extensions which stand as barriers to a proper solution of this problem.

If there were no other way, nor any better one, to obtain rapid transit in this city than by the system set forth by the Manhattan Company, I should say by all means let the system be thus extended, but every one within reach of my voice knows that other methods of construction can be adopted which are free from a large number of the objections which are inherent to the elevated railway system, and knowing this, we are justified in doing what lies in our power to aid in the adoption of such other methods.

In investigating the various systems it is pertinent to inquire:

When was each proposed?

How comprehensive is its character?

Which presents the most modern and progressive engineering?

Which will best satisfy the future as well as the present needs of New York city?

Which will cost least, be most quickly constructed, and hence most strongly appeal to capital?

To satisfactorily answer these queries there are three things to be determined. They are:

Motive power.

Method of construction.

Routes.

In order that the Commission may have the greatest latitude of judgment, these should be determined in the order named, that is, the determination of motive power should precede that of construction, and the method of construction that of route.

Two systems of motive power only are under consideration, steam and electricity, the former a well-known agent whose advantages and disadvantages are well known, the latter a newer application of force, one in which the layman is not so well versed, but one whose advantages and possibilities are well understood, and most thoroughly relied upon, by those who have made it their particular study.

The vital importance of letting the determination of motive power precede that of construction and route will be clearly illustrated by noting the limitations upon construction. There are five general plans which have been proposed.

A. An elevated steel structure, similar in character to the Manhattan system, and occupying the public streets.

B. The viaduct masonry construction similar to some of the London sections of English trunk line systems, the viaduct road of Berlin, or the Broad street section of the Pennsylvania railroad in Philadelphia, to run through the middle of building blocks, and to span the streets with steel arches.

C. A shallow tunnel made by excavating the streets, removing or diverting the existing system of pipe services of all kinds, running the tracks in one or two tiers, either superposed, or in different vertical planes, the street to be floored over with a steel girder structure. The enclosed track would be something like the Fourth Avenue Harlem road tunnel except that it would be entirely enclosed.

D. An iron tubular closed tunnel construction, the tubes running at a depth of from twenty to forty feet below the surface, and built something like the North River tunnel, but individualized like the Suburban and South London road constructed in London by the Greathead interests, and opened for regular service last November.

In this system the various tracks would be generally independent, and the way and express routes likewise independent save at common intersecting stations.

E. A deep rock two-track tunnel identical in character with every other rock or mining tunnel with which we are all familiar.

If electricity be adopted as a motive power, the Commission will be left untrammelled to determine which of these constructions is preferable.

If steam is adopted, considerations of construction are at once limited to plans *A* and *B*, and even then there exists a limitation in the viaduct system not yet realized, to which I will soon refer.

I think it may be taken for granted.

First, that a West Side route should come as near Broadway as possible;

Second, that a four track system is essential, because higher speed and greater capacity are required, and both way and express service must be provided.

An elevated structure necessitates the appropriation of streets already needed for other purposes. If for four tracks in one plane such a system is impossible in most of our streets. It is hardly necessary to further discuss the objection to this system.

A viaduct construction requires for every foot of way except at street crossings the condemnation and purchase of property of great value in the business heart of the city, of an aggregate far exceeding the proper cost of road construction. It means the tearing down and re-erection of many buildings, the interruption and cessation of the business carried on, with all the necessary legal complications which will surely follow, thus increasing the cost of construction in an unknown but material way, and it would require extra provision of capital for the purchase and alteration of these buildings.

But, as I have intimated, there is a distinct limitation to this plan in the simple one of motive power. There are two plans of constructing such a viaduct; one by making a clean cut through the buildings, leaving the roadway uncovered, and the other by tunneling through the buildings. If the former plan is adopted there would be thrown away a continuous strip of block space in the most valuable section of the city from twenty-five to fifty feet width, according to whether the tracks are in one or two planes, and from fifty to three hundred feet in height. Although the value of this wasted space is well-nigh incalculable, it is the only plan by which steam could be made available, because, if the roadway is covered in the block spaces and steam be used, the same objectionable features would exist which have given the Fourth Avenue Harlem tunnel so unenviable a reputation, and the damage to property would be even more pronounced. If, however, the viaduct construction were adopted, economy would demand the tunneling rather than the cutting down method of getting through buildings. This consideration would then require the abandonment of steam and the adoption of electricity.

But suppose this suggested construction and motive power be adopted in the populous portion of the city, and the street crossings be left open; there would then be that most disagreeable alternation of light and darkness, or of a greater or less degree of light, which is another of the objectionable features of the Fourth Avenue tunnel, and hence the crossings themselves must be enclosed, and with what result? The additional disfigurement of the street may be here ignored, but there would be simply an elevated tunnel of the most costly character, supported on a masonry viaduct, and a system of most questionable financial promise.

In considering an elevated or viaduct structure following the approximate route outlined, it is well to note what obstructions would be met in its course in the lower part of the city.

How, for instance, would such a system cross the Manhattan system at 34th, 53rd and 65th streets? Would a grade crossing be advisable or permissible? Unquestionably not, for the danger of collisions and the delays and blocks would at once condemn it. If not a grade crossing, then which road would be uppermost? The Manhattan being already in possession, the new system must do the crossing, and at an abnormal elevation. What would be the effect of the operation of such a road upon the Metropolitan Opera House?

As regards stations, the elevated and viaduct plans require separate up and down platforms, and it would be interesting to inquire how, with the limitations which must exist on roads of this character, it is possible to serve way and express tracks on a common level except by making them common at the way and express stations. The danger attending this practice must be apparent.

Returning again to the question of motive power, it is important to know what are the objections raised against the use of electricity. About the only one made public is that it has not yet been used on as large a scale as would be required in the proposed system. This reason seems ultra conservative, and it is to be regretted that on a subject of such vital importance, there has not been made a more thorough public inquiry.

This same view was taken of the application of electricity to street railway propulsion only three years ago. There was scarcely an engineer, a street car builder, a street railway constructor, or a capitalist, who did not laugh at the claims which were made for it, and yet in this short time there has been a total revolution of feeling. There is not, probably, a street railway manager in the United States, who does not thoroughly believe that electricity is the present and coming power for street railways, and who, if he were constructing a new road, or re-equipping an old one, would not at once, or in the near future, adopt electricity if he could get the necessary rights to do so; and it should be borne in mind that the equipping of these roads has meant, in very many cases, the entire rebuilding of the track, the purchase of new cars, the building of costly stations, and in short, the investment of a greater capital than had already been invested in the original plant, so that fifty million dollars is a small estimate of the sum which stands invested to-day, in this one industry alone.

If, however, the Commission is still in doubt, then in order to get a more intimate knowledge of what electricity can do as a motive power it would seem proper,

First: That a time be set apart for the public examination of electrical engineers and contractors.

Second: To require a private statement from electrical engineers, confidential, if desired, as to any new developments not publicly known.

Third: To visit two or three of the prominent electrical establishments to see what has been, is being, and what will be, done in general electrical machine construction.

Fourth: To then state what duty would be demanded of electric motors and what guarantees of performance would be required under forfeiture.

If something like this be not done, then I think it safe to say that the rejection of electric motive power will be because of the following reasons: Its novelty; allowing accidents incident to the early period of its developments to outweigh in importance its demonstrated advantages; a conclusion that it is limited in capacity and development, and lack of information as to its past, present, and promised future.

Such a rejection would be upon technical advice relied upon by the Commission.

This, it would seem, ought to be that of the Board of Engineers, not the judgment of any one man, because no one has sufficient experience to warrant such reliance upon his dictum in a matter of so grave import, and on a subject to which so many able engineers are devoting themselves, and the development of which has enlisted so many millions of capital.

The motor equipment on, for example, the present London road is composed of one-hundred horse-power units. That required on elevated railroads is one-hundred and eighty-five horse-power. Attach four motors of the London type to the same circuit instead of two, govern them, as is perfectly feasible, by the same controlling device, and they will outwork any elevated road engine.

Increase the dimensions in these machines one-third only, and two of them will do the work of this engine. Duality may be objected to, but it should be borne in mind that duality of engines is absolutely necessary in a locomotive for successful operation. It is not essential in an electric motor equipment, although advisable for traction purposes. But for that matter double the dimensions of a London machine, and it alone will outwork the two cylinders of the elevated locomotive.

Perhaps one of the most telling arguments in favor of electrical propulsion is the fact that in London another underground road to be operated by electricity is about to be constructed on plans already approved by a parliamentary committee. This road is about six miles long and connects the West End with the city. It forms approximately a diameter of the oval described by the present steam underground railways. A 5,000 h. p. station at the suburban end of the line will supply the current. The trains are to consist of six cars, seating about 340 persons, and will weigh with the electric locomotives 120 tons. The average speed is to be 14 miles an hour including all stops, with a maximum of about 25 miles an hour. Since this weight, power, and seating capacity exceeds that now common on the elevated railroads, it is a somewhat practical answer to the objections made on this point.

There have been no demands for a two-thousand horse-power steam locomotive, but there is not a builder in this country, who, given suitable gauge of track and allowed dimensions of engine, would hesitate a moment to build a locomotive of that capacity.

So too with electric motors. Given the incentive, and before the first foot of roadway is ready on the proposed Rapid Transit System of New York, a two-hundred horse-power electric locomotive will be built which will, under forfeiture, outwork any elevated road engine for speed, pulling capacity, steadiness of work, time of operation, and continuous mileage.

This statement is made from personal knowledge, and with an individual willingness to assume the risk.

Break a single part of the many in a locomotive and it is helpless. Break many of certain parts in an electric motor and it will, although crippled, still operate. In short, the near future will make the electric motor the most reliable machine constructed for power purposes.

What is the experience of other large cities in this matter of rapid transit?

In London the same interest which built the Greathead tunnel has been granted Parliamentary right for extensions, ordinarily most bitterly fought against, with an almost unexampled unanimity.

Paris is considering seriously the question of a great metropolitan underground electric system.

Boston has been advised after most careful investigation that the only proper system for the business portion of the city is an underground electric system.

As regards New York, while unnecessary delay is to be avoided, it is certain that no present delay is half so serious in its consequences as the adoption of an inferior plan by reason of immature consideration, lack of knowledge or information, or in response to popular clamor. The demands of to-day can be best served by plans to meet the future wants of New York as well, while the needs of the future cannot be properly provided for by planning for present limitations. In discussing the subject some time since in a communication addressed to the Commission which contained the gist of much I have already said in this paper, I made the following suggestions:

It is possible that the Commission, while still in doubt about the availability of electricity as a motive power, may feel it incumbent upon them to announce some decision with regard to at least one route. Would it not then be possible to submit two alternative propositions, the preferable one of which could be determined by public comment and criticism and the readiness with which a responsible construction company would bid for the necessary right and franchise?

First, questioning the availability of electricity, select the best system which can be devised other than an underground system, that is, some elevated or viaduct structure. Specify the number of tracks, the route over which it shall run, and make steam the motive power.

Second, accepting the statements which are made in favor of electricity, select the best underground or combined underground and viaduct and surface system, which will answer as far as possible the demands which have been enumerated. Establish the route, the number of tracks, and make the use of electricity obligatory.

Third, demand as regards: *Construction*, earliest time of beginning, greatest freedom from interference, either with streets or existing systems of pipes, least damage to property, most rapid progress of work, earliest completion. *Results*, mean and maximum speeds, number and weight of trains operated, approximate cost of motive power per train mile under these conditions. *Guarantees Under Forfeitures*, against construction damages to buildings or foundations, against future damage claims.

Then let the public discuss the merits of these alternative propositions, and let a construction company or companies bid on these systems and on the franchise, accompanying such bid with a proffer of a certified check of sufficiently large amount, and then see which company will, *a*. Guarantee to build most quickly. *b*. Make the best offer for the franchise. *c*. Offer the highest guarantees, both as to progress, cost and satisfactory operation.

As I close this paper there comes news of most reassuring character, for the chairman of the Commission is reported in Tuesday's *Commercial Advertiser* and in Wednesday's morning papers as stating in the most emphatic manner that the Commission is planning for future New York, and that it will under no consideration even consider the plans of the elevated railroad until after it has determined upon a route to satisfy the demands of that future.

This statement of the chairman is most opportune and will go far to allay the anxiety which has been honestly felt by those who await the result of the Commission's deliberation.

It is also stated, presumably on the same authority, that a system and West Side route from the Battery to the Harlem river has been definitely settled, part underground and part viaduct, and the announcement of this decision will be definitely made next Tuesday. If so, then it would seem that electricity has now the victory, and the particular method of construction and the route selected will form the subject of discussion.

MR. FRANK BICKNELL has accepted the charge of the electric light plant at the hospital, at Kankakee, Ill.

SHALL "ALUMINUM" BE "ALIUM."?[1]

BY OBERLIN SMITH.

IN February, 1890, I had the pleasure of reading before the American Institute of Mining Engineers, at their Washington meeting, a paper entitled "Aluminum in Search of a Nickname." In this essay reference is made to the fact that the nickname "Al" had already been irreverently introduced by many of the people engaged in manufacturing and selling it, in accordance, obviously, with the general tendency of our modern rapid life to condense all our commercial nomenclature into as small a compass as possible.

In accordance with this labor-saving tendency in regard to our tongues and pens, it certainly seems desirable that a shorter name than "aluminium," or even "aluminum," should be found for a metal which is destined to be so largely used in the further evolution of our modern mechanical life—and probably not a little in the electrical engineering of the future. In the paper before mentioned, reference is further made to the fact that the names of the commercial metals now in use are nearly all short, crisp, words of one syllable, as gold, tin, zinc, lead, bronze, brass and steel, while the most common two-syllabled ones, nickel, silver and copper, are also simple and easily spoken.

In further arguing the point regarding aluminum, I suggested as possible future names "Aluum," Alium," "Alim" and "Alm," as being suggestive of the original word for which they might become substitutes, and yet euphonious and easily pronounced. Since the essay in question was printed, my proposed reform has attracted considerable attention in the technical papers, the general preference appearing to be for the word "Alium" rather than for the others mentioned. This word has also been suggested independently by no less eminent a scientist than Prof. Elihu Thomson, who did not know that I had already proposed it. It has been heartily endorsed by Mr. Eugene H. Cowles, a well-known authority upon this metal, in an article in the New York *Tribune*, and by Mr. T. Commerford Martin, Past President of this Society, in the columns of THE ELECTRICAL ENGINEER.

Possibly a practical method of starting this reform would consist of one of the societies mentioned (and why not this one?) appointing a committee to distribute an argument of the case among the editors of the various technical journals, here and abroad, asking for replies as to how many of them would be willing to adopt the new word, should a majority of the whole number agree. This committee could also send communications to the other national engineering and scientific societies, requesting action, or, at any rate, an expression of opinion, upon the same subject. If each society proved willing to appoint one or more members upon a joint committee of conference, a favorable report by such a committee, especially if backed by the technical journals, would undoubtedly command sufficient respect to lead to the adoption of the name in question by the societies themselves at a later period.

If we consider the length of the names "aluminium" and "aluminum," in comparison with other elements, we find that the former is the only five-syllabled one extant. In a list of 64 elementary bodies we find only 18 of them to be words of four syllables, while 29 have three syllables, 11 two syllables, and five one syllable, the latter all happening to be ordinary commercial metals. The question naturally arises, can we afford to put a material which is probably destined to such extensive use as is this comparatively new and beautiful metal in the category of these rarely used and many syllabled elements which, as has been seen, are in a small minority of the whole number? Can we, moreover, afford to let it stand alone, in the whole list of elements, as the only one (excepting, perhaps, mercury, which foolishly has a sort of a synonym) possessing *two* distinct and interchangeable commercial names, as is now the case?

PORTLAND, ORE., INDUSTRIAL EXPOSITION.

This Association will hold its third annual exposition, from September 17th to October 17th, and are making every effort to secure a complete electrical exhibit. Secretary Mitchell says that in this they are receiving a generous co-operation from the entire Pacific Northwest.

The building will this year, for the first time, be lighted entirely by electricity, by means of 100 Thomson-Houston arc, and 600 Edison incandescent lamps.

The exposition includes general and special exhibits from the states of Oregon, Washington and Idaho. The building will be open for the reception of exhibits on and after September 1st, and applications for space and power should be made as early as possible, in order that the management may be fully prepared to meet all requirements for space and power.

The officers of the Association are:—

T. M. Richardson, president; E. A. King, vice-president; G. E. Withington, treasurer; R. W. Mitchell, secretary and superintendent.

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 21st, 1891.

THE NEW ENGLAND PORTELECTRIC COMPANY'S SYSTEM OF TRANSPORTATION.

Since the close of the exhibition of the model of the Portelectric in the "Old South Church," Boston, over a year ago, persistent and unremitting efforts have been made to determine all the conditions necessary for the construction of a commercial line for practical business purposes. Much delay has been caused in the progress of the work by the severe and uncalled-for test to which the invention was put by the contracted course which the company was compelled to adopt, and which gave little opportunity for straight runs, so essential to the development of high speed.

The present experimental track is situated at Dorchester, Mass., and the tests have been carried on under the supervision of Mr. J. T. Williams, the inventor of the system, assisted by Prof. A. E. Dolbear, the electrician of the company. In a report recently made by Mr. Franklin L Pope, we gather some interesting details as to the methods employed and the possibilities of the system.

The experimental plant at Dorchester comprises an endless track, Figs. 1 and 2, elevated upon a wooden trestle a few feet above the ground, 2,794 feet in circuit, consisting of one tangent of 492 feet, and another of 430 feet long, united at their ends by two curves, one of which is 1092 feet long and 282.5 feet radius, and the other 780 feet long and 234.4 feet radius. The track in the first tangent of 588 feet, is level, while in other portions of the circuit are grades rising to a maximum of 4½ per cent., or 227 feet per mile.

The track consists of an upper and a lower rail, formed of bar-steel ¾ inch by ¼ inch, fastened by countersunk screws to stringers. The upper stringer is of wood, 2 inches square, and the lower also of wood, 2 inches broad by 4 inches deep. The upper rail is supported and braced at intervals of about 3 feet.

The carrier, Fig. 3, is a hollow cylindrical projectile of wrought iron, with ogival ends, the cylindrical portion being 8 feet long and 10 inches in diameter, the length 12 feet over all, and the weight approximately 500 pounds. It has capacity to contain, say, 10,000 letters, weighing, perhaps, 175 pounds. It is provided with two flanged wheels above, and two underneath, all of which, being fitted with ball-bearings, revolve with very slight friction.

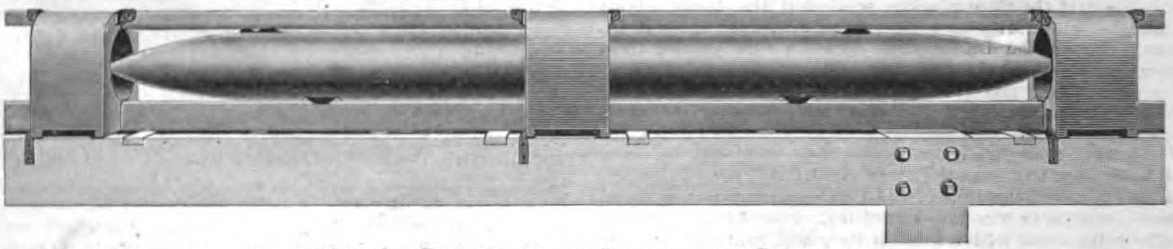


FIG. 3.—CARRIER OF THE PORTELECTRIC SYSTEM.

The propelling power is derived from a series of hollow helices of insulated copper wire, each of which encircles the track and carrier. These are fixed along the permanent way at intervals measuring 6 feet from centre to centre. Each helix is composed of 630 turns of No. 14 copper wire, in five layers, weighing about 20 pounds, and having a resistance of about 5 ohms. A contact wheel, mounted upon the carrier, and running in contact with the upper track-rail (which is divided into sections, and utilized as an electric conductor), connects the several helices in succession with the source of electricity as the carrier moves forward upon the track.

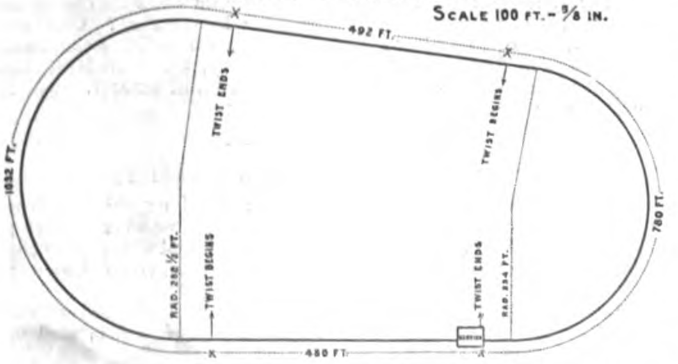


FIG. 2.—DIAGRAM OF EXPERIMENTAL PORTELECTRIC LINE.

The electric current is supplied by a dynamo having a maximum capacity of about 8,000 watts, or a little over ten horse-power, driven by a steam engine rated at ten horse-power.

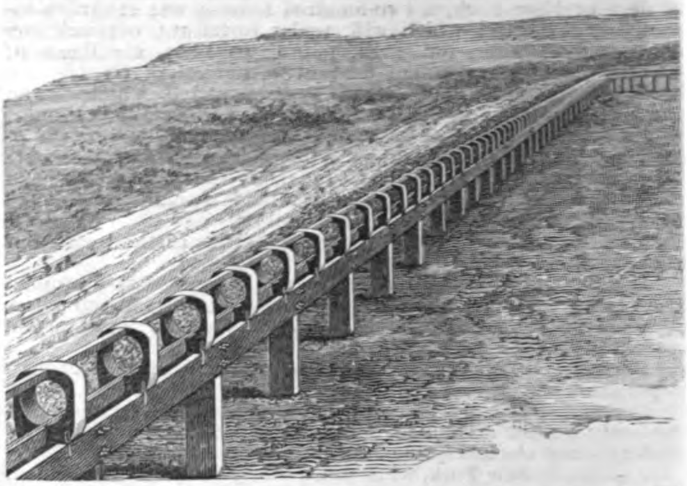


FIG. 1.—PORTELECTRIC TRACK AT DORCHESTER, MASS.

Experiments were first made to determine the maximum speed of carrier which could be obtained from the appliances in use at the time of inspection. This was found to be 2,784 feet in 56.5 seconds, or 49.3 feet per second, equal to 33.5 miles per hour.

The consumption of electric current, or rate of electric work while the carrier was in motion, was between nine and ten electric horse-power. The maximum tractive effort with a current of ten amperes was found to be 80 pounds. The electrical force producing this magnetic attraction was 6,300 ampere-turns.

The rate of acceleration was found to be as high as 4.5 feet per second. The force of traction required to produce this acceleration, with the carrier of 500 pounds' weight, is about 70 pounds.

A tractive effort of 70 pounds, exerted upon the carrier moving at the rate of 50 feet per second, requires the expenditure of 6.3 horse-power, or 4,712 watts. As the average electrical energy supplied appeared to represent something like 8,000 watts, the efficiency of the helices and carrier, considered as an electric motor, may be estimated at about 60 per cent., which figure agrees very well with other determinations of solenoid magnets.

There are eight hundred and eighty helices, and seventeen thousand six hundred pounds of insulated wire per mile in the helices, in addition to that in the main conductors.

As each coil is ordinarily in circuit for only a fraction of a second at a time, it is evident that a volume of current per unit of sectional area may be used with impunity in this case, which would be wholly inadmissible under ordinary conditions.

The provision for power required to propel the carrier at the assumed rate of 150 miles per hour, may be taken at fifteen hundred volts and seven amperes per forty miles of single track, or about 0.33 horse-power of *generating capacity* per mile. This may be estimated, including steam plant and buildings, at $125 per horse-power, or, say, $45 per mile.

The actual cost of the electric power required to propel the carrier at this rate may fairly be taken at five cents per horse-power hour, including cost of attendance at stations. The mere cost of *power* for propelling a carrier from Boston to New York would therefore not exceed seventy-five cents per trip.

Excessive estimates of the cost of a double-track line, making liberal allowances in all directions, do not exceed $35,000 per mile, or about $7,000,000 for a line between Boston and New York.

THE ELECTRIC CLUB'S RECEPTION TO THE INSTITUTE.

A VERY pleasant and memorable evening was spent at the house of the Electric Club on Thursday evening, by the members of the Institute, about 400 or 500 gentlemen connected with electrical pursuits being present at the reception tendered by the club to that body. The reception was of a wholly informal and social nature, but was made specially interesting by the Loan Collection of early electrical books, apparatus, autographs, etc., got together by the Entertainment Committee of the Club and arranged in the Lecture Room and Library. This exhibition comprised about 150 rare and important electrical books, from the collection of Park Benjamin, and so arranged in groups that each case, by means of these volumes and their contents, told the story of the period at which they were written. The first case, for example, contained Diogenes Laertius, Agricola on Metals, Gilbert's De Magnete, and many of the works spoken of by Dr. Gilbert. These books were grouped as "The Dawn of Electricity." Among the rarities and curios of the collection were James Watt's French Grammar, with his autograph and the date 1752 in his handwriting; an early electrical book with Benedict Arnold's autograph; the early Galvani and Volta treatises, and five of Ampere's papers, with autograph, and a letter of Arago. This collection, which is but a small part of Mr. Benjamin's collection, was studied with the greatest interest. The exhibit also contained Mr. Edward Weston's copy of De Magnete; Dr. Lugo's copy; and that of Mr. C. L. Clarke, with Gilbert's autograph presentation of it to Jo. Sherwood on the title page. Among the miscellaneous collection contributed to by Messrs. Edison, Weston, Clarke, Webb, Wetzler, F. L. Pope, Barré, Hammer, Martin, Chandler and others, were early books on electricity, relics of the early telegraph and cable days, a number of autographs, etc. The *Century* Co. loaned a piece of the wire used by Morse and Vail in 1838, and the University of the City of New York loaned the first battery used by Morse.

The collection of early apparatus included one of Ezra Cornell's insulators from Mr. F. L. Pope; Mr. Wm. Stanley's first transformer, 1885–6; the Davenport electric railway of 1835–7; an Edison hedgehog transformer of 1878, used to run 20 of his platinum lamps; a fine collection from Mr. E. F. Gennert illustrating "The Evolution of the Socket;" a selection from Mr. W. J. Hammer's magnificent collection of incandescent lamps, as well as his rare books, photographs, autograph portraits, etc.; and the first chandelier ever wired for incandescent lighting, from the collection of Mr. Luther Stieringer, who also loaned some of his curiosities of the early incandescent art. Around the Lecture Room were hung a selection from Mr. Edward Weston's fine collection of autograph portraits, and the mantelpieces were also graced with pictures, including two oils illustrative of submarine cable work, by Mr. H. D. Gardiner, loaned by *Scribner's Magazine.*

In the Library were shown some interesting early autograph letters, etc., of Morse and Henry, and a portion of the very interesting War Collection of Mr. A. B. Chandler, who, as a young telegrapher, did duty with Stanton and Lincoln. The collection contained very interesting autograph papers of those two great men, as well as of McClellan, Spinner, Bingham, Seward, Barnum, Morse, Edison, Orton and others, as well as such curiosities as Confederate telegraph register paper, war telegraph ciphers, etc.

During the evening a collation was served, and music was played by the Bridgeport Mandolin band. Before the evening closed, President Insull expressed, in a few happy remarks, the pleasure felt by the Club in thus entertaining the Institute, and the hope that the alliance would be made even more friendly and cordial, for the furtherance of their common interests and the promotion of electrical welfare. The compliment was acknowledged in behalf of the Institute in a most eloquent speech by Mr. Edward Weston, who, like Mr. Insull, spoke as a member of both organizations. Mr. Joseph Howard spoke for the press, and Prof. George Forbes replied for the electricians from abroad. The announcement was then made that a talk would be given at the Club on Thursday evening, May 28, on "The Tools of Modern Warfare," by the distinguished inventor and pioneer electrician, Mr. Hiram Maxim, who had been one of the guests of the evening. Thus closed one of the most enjoyable and successful of the many notable "Nights at the Club."

THE SERVICES OF GEN. ELECTRICITY.

In a retrospect of the Civil War, John C. Ropes, an acknowledged authority on military science, says, in the June *Scribner*, that steam and electricity made possible for Grant and McClellan what had been impossible for a Napoleon. Otherwise the predictions of Palmerston and Napoleon III., that the North would fail, would probably have been fulfilled.

SMALL EDISON SLOW SPEED MOTORS (1891 TYPE).

THE uses for small motors, that is, from $\frac{1}{16}$ of a horse-power to ½ horse-power, inclusive, are surprisingly numerous. Work formerly performed by hand is now, for the first time, done by power; and every day some new application of the small electric motor is made. Recognizing this fact, Mr. Edison has designed a motor with special reference to its use in small sizes, in which he has embodied the features of minimum of attention and repair, high efficiency, small first cost, slow speed, and perfection of mechanical detail.

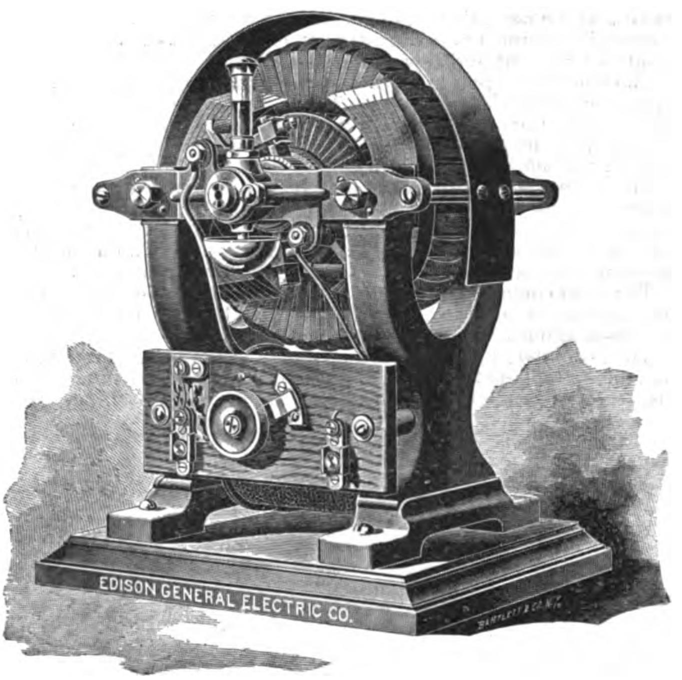

EDISON GENERAL ELECTRIC CO.
BARTLETT & CO. N.Y.

FIG. 1.—EDISON SMALL MOTOR.

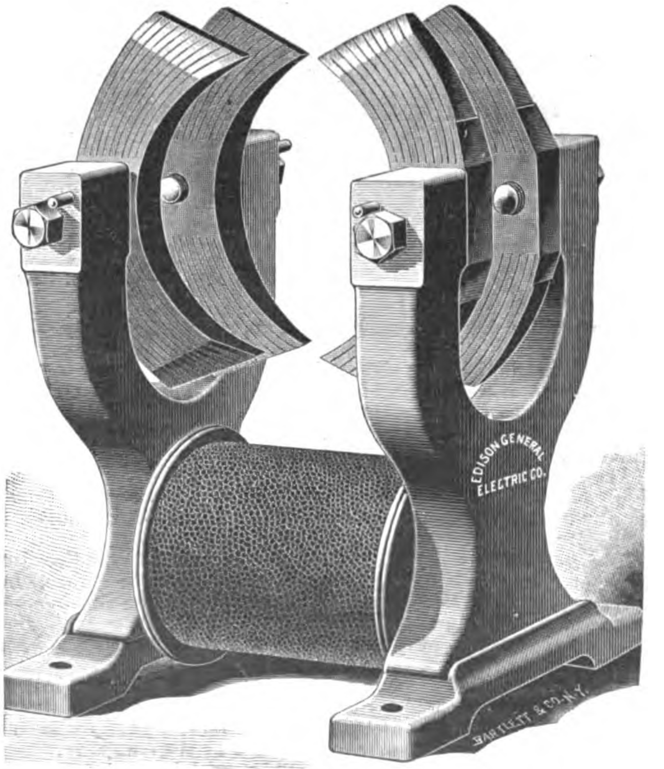

EDISON GENERAL ELECTRIC CO.
BARTLETT & CO. N.Y.

FIG. 2.—FIELD OF EDISON SMALL MOTOR.

The motor has been so designed that no adjustment of the brushes whatever is required, the brush holders being fixed in position and requiring no attention after being once adjusted. Lubrication being accomplished by the use of grease instead of oil, very little attention is needed in that particular.

By connecting the coils of the armature with the commutator by German silver wires, the sparking which has heretofore been found so objectionable in small machines is entirely eliminated. This is a feature which will be at once appreciated by power users. As each coil of the armature is wound independently of the others, any coil can be replaced with the greatest ease.

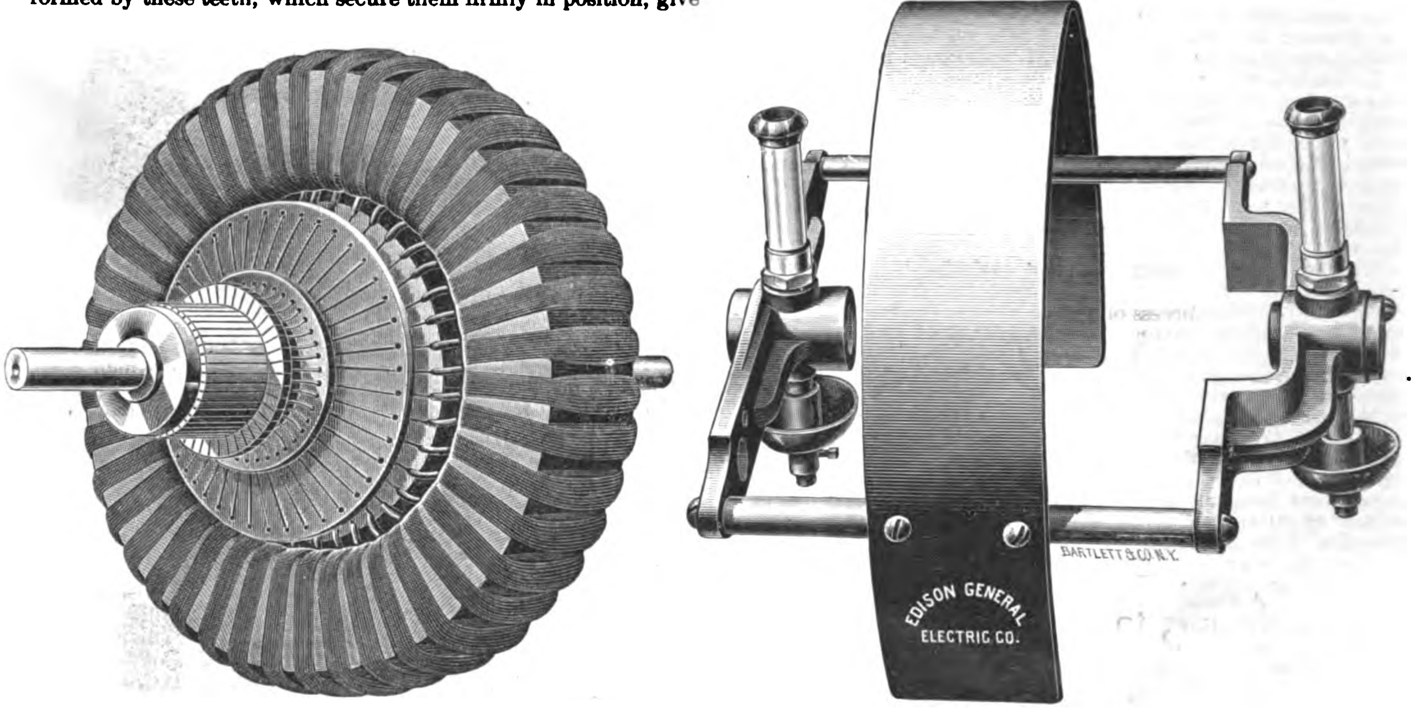
The bearings of the armature shaft consist of removable brass sleeves, which are adjusted to permit of perfect alignment. Upon the wearing of the brass bearings by continued use, they can be readily slipped out and new ones substituted in a few minutes.

The general arrangement of the motor is shown in Fig. 1 of the accompanying illustrations. The armature revolves in a magnetic field, the lines of force being brought through the armature on both sides of the ring by means of specially shaped pole pieces made of the softest Norway iron.

The poles, shown in Fig. 2, being built in strips, secure a lamination which prevents the heating of the fields, thus permitting the motor to run cool even when overloaded. These wrought iron pieces are attached to the magnetic frame, which at the same time forms the base upon which the machine is mounted.

The single field magnet coil is placed below the armature. This brings the centre of gravity low, and hence adds to the steadiness and solidity of the machine.

The armature, Fig. 3, is built of the softest laminated wrought iron, and is provided with teeth. The coils are placed in hollows formed by these teeth, which secure them firmly in position, give them a positive driving arrangement, and prevent slipping of the coils.


BARTLETT & CO. N.Y.
EDISON GENERAL ELECTRIC CO.

FIGS. 3 AND 4.—EDISON SMALL MOTOR ARMATURE AND GUARD.

This construction also allows the projecting teeth to be brought in the closest possible proximity to the pole pieces, so that the field magnets can be brought very close, lessening the air gap, without the slightest danger of abrading the winding of the armature.

These motors have been designed to meet the demand for a highly efficient machine which would be at the same time of low cost, by the adoption of a type employing the smallest number of parts with the lowest possible weight of material.

The great desirability of slow speed in the operation of the electric motor is recognized by the Edison General Electric Company, as this reduction results in a great saving in the wear of commutator, bearings and brushes, and admits of the application of these machines to purposes where the use of motors has heretofore been impractical.

The details of the mechanical construction of the new Edison motor have been as carefully considered as the electrical features, and both material and workmanship have received the same care and attention as the largest machine built by the company.

The armature of the motor is provided with a guard, shown in Fig. 4, which protects it from accidental injury, and also forms a partial cover for the machine.

All parts of the motor are made interchangeable so that new parts can be fitted without trouble.

The machines are equipped with a mahogany switch-board upon which are mounted the terminals for making circuit connection, and also a strong and simple switch, together with a safety fuse for protecting the motor from excessive current.

This type of machine is built in sizes from $\frac{1}{16}$ to $\frac{1}{2}$ h. p. The following table gives the various speeds, currents and weights.

Type in h. p.	Volts.	Amp.	Speed.	Weight.
$\frac{1}{16}$	125	.4	2200	$14\frac{3}{4}$
$\frac{1}{8}$	125	.8	2000	$20\frac{1}{4}$
$\frac{1}{4}$	125	1.6	1300	$28\frac{1}{2}$
$\frac{1}{2}$	125	3.2	1500	$37\frac{5}{8}$

It will be noticed that the weights of these motors are very low.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE annual meeting of the Institute was held at its headquarters, 12 West 31st street, on May 19, at 8 P. M., President W. A. Anthony in the chair.

Secretary R. W. Pope presented the annual report of Council. It showed a total effective membership of 541, a net gain of 114 during the year. The secretary's balance sheet showed $5,727.96 received; and the disbursements of the year, taking into account the balance over from last year, showed a balance in hand of $752. During the evening $500 was voted out of the balance toward the building fund, for which Messrs. Phelps and R. W. Pope were appointed trustees.

Prof. Anthony appointed Messrs. F. L. Pope, T. C. Martin and J. W. Howell as a nominating committee. The report of the committee was accepted, and the nominations were made with unanimity. Subjoined is the full list of officers, the new members being indicated in italic and the re-elections in small caps.

PRESIDENT. *Alexander Graham Bell.*

VICE-PRESIDENTS. *T. D. Lockwood, Carl Hering, W. J. Hammer*, Prof. F. B. Crocker, F. J. Sprague, Joseph Wetzler.

MANAGERS. *Dr. Louis Bell, H. L. Webb, Prof. A. G. Compton, J. Hamblet*, Dr. F. B. Herzog, Dr. W. E. Geyer, H. C. Townsend, F. R. Upton, J. C. Chamberlain, P. B. Delany, H. A. Foster, H. W. Leonard.

SECRETARY. R. W. Pope.

TREASURER. G. M. Phelps.

The meeting discussed a few matters of detail and routine, and then adjourned to the Edison station in West Twenty-Sixth street, which was carefully inspected.

At the morning session of Wednesday, Prof. Crocker read a paper on "The Perfection of the Stationary Electric Motor," which was followed by one by Prof. Hall, of Harvard, on electrical tests of cylinder condensation.

After the adjournment for lunch, Prof. E. L. Nichols, of Cornell University, read a paper entitled "Some Data Concerning the Photometry of the Arc Lamp;" Mr. Carl Hering, one on "A New Graphical Method of Calculating Leads for Wiring;" and Dr. F. A. C. Perrine, one on "Some Results in the Practical Utilization of Electric Welding.

The evening was given up to a lecture by Mr. Nikola Tesla, at Columbia College, on "Experiments with Alternating Currents of High Frequency." This was largely attended, as on previous like occasions, Dr. Dwight's room being filled to overflowing, the audience including a great many ladies. The lecture was profusely illustrated by experiments.

On Thursday morning the members met first at the Crocker-Wheeler Motor Factory, and a large number inspected it with much interest. Afterwards at headquarters papers were read by Prof. Geo. S. Moler. on "A New Device for the Measurement of Alternating Current Potential;" by Mr. M. E. Thompson on "A Study of the Fluctuations of Electromotive Force in the Open Coil Armature of a Constant Current Machine," and Mr. Frank J. Sprague, on the considerations which should determine the Rapid Transit System in New York city.

After lunch, a paper was read by Mr. G. W. Walker on "Electric Meters" with illustrative experiments, and Dr. W. H. Wahl, delivered an address on "The Aluminum Problem: Retrospective and Prospective." This was accompanied by a most interesting exhibit of the aluminum products of the Pittsburgh Reduction Co., and the alloy products of the Aluminum Brass & Bronze Co. of Bridgeport. Mr. Oberlin Smith also read a paper entitled: "Shall Aluminum be Alium?"

The chair also was given power to appoint delegates to represent the Institute at the Frankfort Exhibition Electrical Congress.

The discussions on these papers were remarkably lively and good, and were participated in freely by Profs. Elihu Thomson, Anthony, Crocker, Nichols, Geyer, George Forbes, Messrs. Weston, F. L. Pope, Wheeler, Lockwood, Bell, Sprague, Waldo, Mailloux, Sweet, Rice, and many others.

The meeting closed on Thursday evening with the reception tendered to the Institute by the Electric Club, at the Club House.

A large part of the success of the meeting is due to the efforts of the local committee, comprising Messrs H. A. Foster, chairman, Binney, Reid, Caldwell and Lieut. Ives. A special badge provided by the committee in the shape of a horseshoe magnet, made out of aluminum, with the letters A. I. E. E., and with 1884-91 on the keeper, proved very popular. A word of praise is also due to Mr. W. W. Stadler, the steward of the Electric Club, whose services were placed at the disposal of the Institute, with the result that the collation each day was perfect in every respect.

A large crayon portrait of Prof. Anthony, the retiring president, has been presented to the Institute, and now hangs on the walls of the meeting hall.

Letters to the Editor.

A CORRECTION.

I find certain errors in the table of formulæ accompanying my paper read at Montreal, and printed in THE ELECTRICAL ENGINEER of May 13, which errors are typographical ones made at this office. Will you kindly make the following corrections:

1. In the formula for Power at Motor Pulley, which reads

$$M = \frac{D \times \text{h. p.} \times 1,600}{V \times e \times P},$$

the number 1,600 in the numerator should be 16,000.

2. In the formula of Weights For Any Case, which is

$$T = \frac{C \times D^2}{V \times 746.0},$$

the decimal point following the 6 should be struck out, and the figure read 7,460.

In the definition of *G*, read "delivered *to* conductor" instead of "delivered *by* conductor."

H. WARD LEONARD.

Edison General Electric Co., N. Y. City.

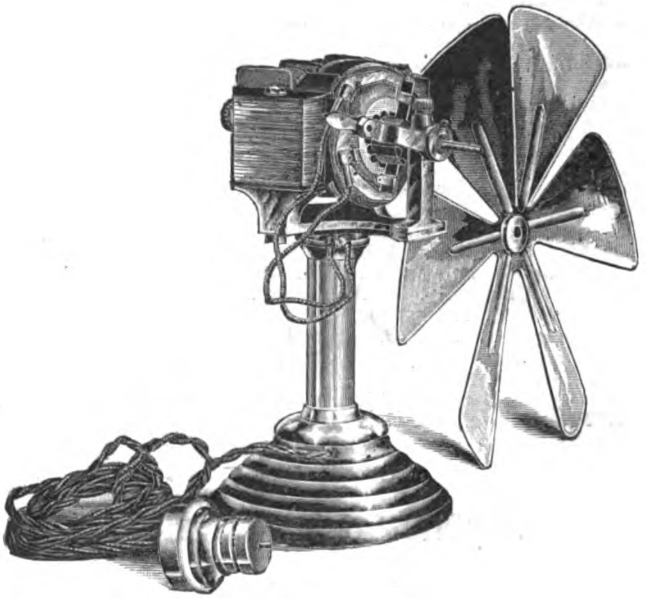
AN OPPORTUNITY AT CORTLAND, N. Y.

The Hitchcock Mfg. Co. being about to move its wood working plant to the South, desires to find a purchaser for its electric light plant as a going concern. The plant consists of arc and incandescent apparatus, and the city now calls for a considerable increase in the lighting. With the plant goes a franchise and a contract for lighting the city of Cortland for ten years, of which only about two have expired.

THE NEW WESTINGHOUSE FAN MOTOR.

THE Westinghouse Electric and Manufacturing Co. are constructing fan motors which they believe to embody all the salient points required in an economical and perfect ventilator. The device has been very thoroughly tested and it has proved to have many advantages. It can be successfully used on an alternating incandescent circuit. Attached to any ordinary lamp socket, it will not use more current than one lamp. One of the motors was placed in one of the company's offices last November, where it has been running without interruption for six months. During all this time, it has required no attention whatever, not even the application of a lubricant being necessary.

The armature coils and the wires leading from the armature to the commutator are completely imbedded in a cementing material. This method of imbedding the delicate parts of the apparatus precludes all danger of short-circuiting and it obviates any breaking of the wires by rough handling.



WESTINGHOUSE FAN MOTOR.

The speed of the Westinghouse fan motor can be varied in a manner so simple that even a child may be entrusted with doing it. The motor has two carbon brushes, which are set so as to work automatically; at the same time, they need not be renewed for years. A moving of these brushes to the left or the right causes the armature either to revolve fast or slowly. Apart from the usefulness of this little apparatus, it is highly ornamental. The fan is nickel-plated and the stand on which it is mounted is of brass. The fan motor can be carried about to any part of the room, as it only weighs about nine pounds.

Legal Notes.

THE GREAT WESTERN TELEGRAPH CO.

Master in Chancery Boyerson filed his report in the Circuit Court at Chicago, on May 2, in the celebrated case of ex-United States Senator Charles B. Farwell against the Great Western Telegraph Company to set aside the claims of Selah Reeve, the Commercial National Bank, George F. Harding, and John Clark Hilton, and to vacate an assessment of 35 per cent. against 1,200 stockholders of the company to meet an alleged indebtedness of $350,000. This assessment, it was charged, was void because of the fraudulent claims allowed against the estate.

The Master recommends that the decree of assessment be set aside, which relieves the stockholders; that the claims of Selah Reeve and Thomas J. Sutherland against the estate be expunged as invalid; that George F. Harding be compelled to account for some $60,000 alleged to have been received by him in excess of the amount of his claims; that Sutherland be obliged to account for the claims held by him against the company, and that a perpetual decree be entered against Sutherland, Harding, Franklin, and Gray for the amount received by them from the sale of the lines of the company. The Master finds that the decree of assessment was procured by fraud.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the council held May 19, the following applications for associate membership were voted upon favorably:

Alden, James S., Assistant Manager, with L. H. Alden, 486 River Drive, Passaic, N. J.
Ayer, James I., General Manager, Municipal Electric L. & P. Co., 322 Pine St., St. Louis, Mo.
Bowman, Fred. A., Electrical Engineer, N. Y. Isolated Dept., Thomson-Houston Electric Co., 65 Columbia Heights, Brooklyn, N. Y.
Colville, Frank C., Electrician and Inventor, 1503 Seventh ave., Oakland, Cal.
Essick, Samuel V., Electrician, The Essick Printing Tel. Co., Yonkers, N. Y., 171 Broadway, New York City.
Everest, Augustine R., Electrical Expert, Thomson Electric Welding Co., Astor House, New York City.
Hancock, L. M., Supt. of Construction, Western Electric Co., 22 Thames St., New York City.
Hewlett, Edward M., Electrical Engineer, Isolated Dept., Thomson-Houston Electric Co., 65 Columbia Heights, Brooklyn, N. Y.
Mason, James H., Electrician and Supt. Mason Battery and Electrical Co., 120 Park ave., Brooklyn, N. Y.
Smith, Oberlin, President and Mechanical Engineer, Ferracute Machine Co., Lochwold, Bridgeton, N. J.
Squier, George O., Lieut. U. S. A., Student of Physics, Johns Hopkins University, Baltimore, Md., Box 243.
Stone, Charles A., Manager with E. S. Webster, Mass. Electrical Engineering Co., 4 P. O. Square Boston, Mass.
Uehling, F. A., Ass't. Supt. and Chemist, U. S. Aluminum Metal Co., Boonton, N. J.
Wason, Chas. W., Electrical Engineer, East Cleveland R. R. Co., 1762 Euclid ave., Cleveland, O.

Reports of Companies.

SCOTT ELECTRIC MANUFACTURING CO.

The annual meeting of the stockholders of the Scott Electrical Manufacturing Company was held at the office of the company, No. 1 Exchange Place, Jersey City, May 15th, and the following Board of Directors elected:—J. G. Scott, B. H. Herbert, E. M. Brown, J. Earl Brown and Richard Deming. President and general manager, J. G. Scott; treasurer, Thomas I. McCloud; secretary, B. H. Herbert,

THE ELECTRIC MUTUAL INS. CO. has just issued some very interesting data and circulars regarding its praiseworthy work. Its rate of premium on acceptable risks averages about one per cent. per annum, and dividends, by reason of its scientific and business-like methods, and which will be paid at termination of each policy, are expected to materially reduce that rate. The company received its charter in May, 1890, and issued its first policy on the 15th of that month. The first eleven and one-half months have yielded over $47,000 in premiums. Although the expenses incident to the first year have necessarily been large, the company has declared a twenty per cent. dividend payable on premiums expiring in May, 1891, and added an equal amount to reserve. Each policy participates in the success of the twelve months preceding the date of expiration of the policy; *i. e.* the premiums, interest and other items of income for the preceding twelve months are added together, and from that sum is deducted the aggregate sum of losses and expense for the same period.

DIVIDENDS.

FAIRFIELD, ME.—The Electric Light Co. has declared a semi-annual dividend of 3 per cent.

THE EUREKA TEMPERED COPPER CO., of North East, Pa., report that their largely increasing business has necessitated the enlarging of their plant, and they are now laying the foundation for a new moulding room 50 x 140 feet, hoping that the increased facilities which this addition will afford, may enable them to meet the increasing demand for their tempered copper.

Appointments, Etc.

MR. C. C. UPHAM has resigned his position as manager of the Salt Lake Rapid Transit Co. and has been appointed manager of the Lincoln City Street Railway Co., of Lincoln, Neb.

MR. C. H. STICKLES, who has been secretary of the Snohomish, Wash., Electric Light Company ever since its organization, and for two years its general business manager, has resigned his position with that company, and has accepted a position with the Edison company to take charge of their work at Portland, Ore.

MR. E. A. SWEET, of Milford, Mass., has accepted a position as electrician and manager of an electric light company in Augusta, Ga.

MR. W. A. RUDD has taken charge of the Western Union telegraph office, at Marquette, Mich., and Mr. L. S. Humes has gone to Supt. McMichael's office, at Minneapolis.

MR. S. DANA GREENE has been appointed consulting electrician to the Burton Electric Co., of Chicago, who control the Burton heater, with which Mr. Greene conducted some of the earliest experiments in street car heating by electricity. The appointment will not in any way interfere with Mr. Greene's work as assistant to the second vice-president of the Edison General Electric Co.

MR. S. ASHTON HAND, of Phila., a widely-known mechanical engineer, member of the American Society Mechanical Engineers, and lately general superintendent for Morris, Tasker & Co., has joined the forces of the Equitable Engineering & Construction Co. Mr. Hand will take entire charge of the mechanical engineering department of the Equitable Co., whose offices are in the Drexel Building, Philadelphia.

MR. H. E. ALLEN, who has been manager of the Central Union Telephone Exchange at Sandusky. has been transferred to the exchange at Canton, O.

MR. WALTON STORM, a lawyer of this city and a graduate of the Columbia College Law School, has been appointed by Gov. Hill to fill the vacancy as commissioner on the New York Board of Electrical Control. He has already been sworn in.

Obituary.

WELLS W. LEGGETT.

The death is announced of this well-known patent lawyer. He was president of the Detroit Brush Electric Light Co., and was also prominently interested in a number of other large enterprises. Mr. Leggett was born in 1847 at Farmington, O., and after war service, etc., began the practice of patent law in 1872.

Stock Quotations.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of May 23, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80½	Edison Gen. Elec. Co	101
American Tele. & Cable	....	Edison Gen. Co. Def'd	....
Centl. & So. Amer	145	Consol'd Elec. Lt. Co	...
Mexican	205	Edison Illn'g Co. N. Y	76
Com. Cable Co	105	U. S. Elec. Lt. Co	30
Postal Tel. Cable	39	North Am. Phonograph	...

BOSTON.

	BID.		BID.
Thomson-Houston	44	Detroit Electrical Works	11½
" Pref'd	25½	Am. Bell	199
" Series C	....	Erie	46
" " D	7½	New England	....
" Int. Co	....	Mexican	[illegible]
Thomson Welding Co	....	Trop. American	.80
Thomson Eu. Welding	....	Edison Phon'gph Doll	.89
Ft. Wayne Co	12		

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash.)	159
Ches. & Pot. Telephone	59½	Eck.&Sold. Home Elec.Ry.	48
Amer. Graphophone	6½	Ge'rget'wn & Tennallyt'wn	58

PITTSBURGH.

Westinghouse El. Man. Co. 14

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 19, 1891.

Alarms and Signals :—

Electric Push Button, M. Straus, 452,397. Filed Oct. 4, 1890.
Details of construction.

Electric Signal Apparatus for Fire Hose, J. F. Klumpp, Jr., 452,506. Filed May 17, 1890.
For communication between a hoseman and the engineer of a steam fire-engine.

Annunciator Drop, H. C. Shivler, 452,585. Filed Feb. 11, 1891.
Details of construction.

Electric Alarm, C. H. Shaffer, 452,785. Filed May 5, 1890.
A closed-circuit alarm system.

Clocks :—

Self-Winding Clock, F. M. Schmidt, 452,392. Filed Nov. 25, 1890.
Employs a small reciprocating motor.

Electric Synchronizing Device for Clock-Hands, A. M. Church, 452,424. Filed Nov. 18, 1889.
Electro-mechanical devices for synchronizing a number of clocks automatically from a standard clock.

Conductors, Conduits and Insulators :—

Insulated Electric Conductor, J. B. Williams, 452,510. Filed Nov. 12, 1890.
Consists, principally, in interposing air spaces between the dielectric and the conductor.

Joint for Electric Conductors, E. Carroll and T. B. Lambert, 452,516. Filed Nov. 18, 1890.
The ends of a conductor are firmly secured and held apart in an insulating block or holder provided with a removable contact piece or plug.

Glass Covered Electric Wire, W. Curry, 452,565. Filed Mar. 5, 1891.
Consists in covering the wire with glass insulators made in tubular sections fitting against each other, each section comprising two parts fitting together and bound upon the conductor by a flexible wire in a peripheral groove.

Insulated Electric Conductor, J. B. Williams, 452,725. Filed Nov. 12, 1890.
Employs isolated or non-communicating air spaces between the dielectric and the conductor.

Composition of Matter for Insulating Purposes, F. Salathe, 452,760. Filed Nov. 12, 1890.
Employs a resinoid hydrocarbon together with sulphur, or with india rubber, gutta percha or oxidized linseed oil.

Composition of Matter for Insulating Purposes, F. Salathe, 452,765. Filed Apr. 22, 1891.
Claims the combination of gutta percha and gum shellac with the new hydrocarbon product of No. 452,760, above.

Dynamos and Motors :—

Dynamo Electric Machine or Motor, F. A. Wessel, 452,420. Filed Nov. 19, 1890.
Relates especially to the arrangement and construction of the cores of field magnets.

Electric Switching Apparatus, G. T. Briggs, 452,359. Filed Apr. 7, 1890.
An adjustable rheostatic switch adapted for reversing and controlling electric motors. Especially applicable for use in hoisting and other operations requiring complete and prompt stopping.

Rheostat, C. D. Jenney, 452,574. Filed June 14, 1890.
An adjustable rheostat for use with dynamos and motors.

Electric Motor, E. Gray, 452,429. Filed July 3, 1888.
Relates to a motor especially adapted for use with the receiving pen of a telautograph system ; operated by impulses and produces a step by step movement.

Brush Holder for Commutators, I. H. Bartholomew, 452,561. Filed Jan. 19, 1891.
Details of a spring-actuated brush carrier.

Bipolar Dynamo or Motor, A. L. Riker, 452,718. Filed Feb. 18, 1891.
Relates to the construction of the continuous frames forming the poles and pole pieces of field magnets.

Lamps and Appurtenances :—

Electric Light Fixture, J. G. Fischer, 452,367. Filed Sept. 8, 1890.
A cut-out for electric lamps.

Leading-in Wire for Incandescent Electric Lamps, R. A. Fessenden, 452,494. Filed Feb. 18, 1891.
Consists of silicon alloyed with a metal having a higher coefficient of expansion than glass.

Electric Arc Lamp, F. Buchanan, 452,633. Filed Jan. 9, 1891.
Relates to feeding mechanism and provides for feeding either or both carbons.

Sectional Shade for Incandescent Electric Lights, A. F. Gartner & J. C. Harris, 452,638. Filed Aug. 30, 1890.

Shade for Incandescent Electric Lights, A. F. Gartner & J. C. Harris, 452,701. Filed Aug. 30, 1890.

Miscellaneous :—

Luminous Sign, C. Beck, 452,514. Filed Dec. 15, 1890.

Explosive Engine, A. Harding, 452,520. Filed Dec. 10, 1890.
Employs electricity for ignition.

Wind Apparatus for Generating Electricity and Charging Secondary Batteries, J. M. Mitchell, 452,546. Filed Dec. 15, 1890.
Combination of a windmill with a dynamo and storage batteries.

Electric Device for Harness, A. B. Holson, 452,571. Filed Oct. 6, 1890.
Substitutes an electric shock for the spur or whip.

Machine for Molding Carbon Points, T. B. Dooley, 452,599. Filed Sept. 15, 1890.

Railways and Appliances :—

Controlling Device for Electric Motors, F. O. Blackwell, 452,422. Filed July 13, 1889.
Claim 1 follows :
The combination of an electric motor having a sectional field and a variable resistance, by both of which agencies the motor is regulated, and a switch independent of the resistance-controller for cutting out or short circuiting a section of the field.
Applicable to electric railway motors.

Controlling Device for Electric Motors, F. O. Blackwell, 452,423. Filed July 13, 1889.
Combines in an electric car a resistance located at an intermediate point, two sets of connections extending to separate points of the car and there terminating in duplicate sets of contacts provided with contact arms and reversing devices.

Electric Railway Train Signal and Recorder, F. H. Brown, 452,515. Filed Dec. 3, 1890.
A system of circuits and apparatus for indicating the position and progress of a train to the operator in the train dispatcher's office.

Electric Insulator, B. Jennings, 452,523. Filed Sept 12, 1890.
A supporting insulator for trolley wires.

Trolley Device for Electric Railways, D. N. Cook, 452,542. Filed July 18, 1890.
A trolley carrier with flexible support.

Crossing for Overhead Trolley Wires, J. Kuehnle, 452,576. Filed Jan. 2, 1891.
Consists of a metallic spider formed of two or more parts crossing each other, and depending interlocking means rigid on the spider, holding the parts together and adapted to engage between the flanges of the trolley.

Conductor for Electric Railways, E. W. Mitchell, 452,611. Filed Feb. 5, 1891.
The conductor extends within an insulated tube or covering, the latter having contact pieces at suitable distances apart throughout its length, normally out of contact with the conductor but adapted to make contact under pressure from a trolley wheel.

Motor Mounting of Electric Cars, S. H. Short, 452,621. Filed Nov. 15, 1890.
Comprises an axially-mounted and directly-connected armature carried upon and cushioned from a driving axle, and non-rotative field-magnets bearing upon the armature axles ; roller bearings are interposed.

Electric Railway Car, S. H. Short, 452,622. Filed Dec. 17, 1890.
A directly applied motor is mounted in journal bearings formed in the yokes of the field-magnets.

Insulator Holder for Electric Railways, B. Jennings, 452,645. Filed Nov. 5, 1890.

Electric Motor or Generator, A. L. Riker, 452,717. Filed Feb. 18, 1891.
Has special reference to the assembling of the laminated frames of the field magnets. Especially applicable to railway motors.

Electric Railway System, D. G. Weems, 452,741. Filed March 13, 1890.
Improvements upon the systems previously patented to the same inventor. Designed to reduce to a minimum the fractional resistance of the air, and to provide convenient means for lubricating moving parts.

Telephones and Apparatus :—

Telephone Transmitter, P. Fitzsimmons, 452,636. Filed Dec. 23, 1890.
Details of a microphone.

Microphone, A. C. F. Muller, 452,758. Filed May 31, 1889.
Employs a rolling electrode.

NEW YORK NOTES.

THE ENGINEERING EQUIPMENT CO., Central Building, Liberty St., N. Y., are making a specialty of the Kellogg iron pole, which they find to be just the thing, and a great favorite among electric railroad men.

THE MURPHY SLATE.—In a recent letter to Mr. T. J. Murphy, 96 Columbus Ave., N. Y., the National Electric Mfg. Co., of Eau Claire, Wis., say : "We use slate for the following purposes : Dynamo switchboards, switchbases, bases for transformer fuses—in short, wherever we formerly used fibre or hard rubber. We know of nothing at present which would answer our purpose as well as your slate, all things considered." Mr. Murphy is beginning to enjoy a large trade as the result of a growing appreciation of the desirable insulating qualities of his special slate.

THE INTERIOR CONDUIT & INSULATION CO., through Mr. H. M. Underwood, their Chicago agent, have secured the contract for the conduiting and wiring for arc and incandescent light, of the Fourteenth street pumping station, of the city of Chicago.

THE CRESCENT INSULATED WIRE COMPANY, of Trenton, N. J., in a recent letter received at this office, say they expect to be running their factory in a few days. They will turn out a superior rubber insulated wire, and no doubt will find a ready market for their goods.

MR. J. STANFORD BROWN, the well-known electrical engineer, who has been connected several years back with electric railway enterprises, has taken an office in the Electrical Exchange Building as a consulting engineer. Mr. Brown is one of the pioneers in the electric light as well as the railway business, and any person contemplating the erection of any kind of an electrical installation will find his services very valuable.

THE MCLEAN ENGINEERING COMPANY, consulting and contracting engineers for steam and electric plants and all work of this character, have taken an office in the Electrical Exchange Building, 136 Liberty street, where they will be found ready for business.

THE STANDARD PAINT COMPANY have removed their offices from 59 Maiden Lane to 2 Liberty street, where they will be glad to meet all their old friends and customers. The well-known trade mark "P. & B." is painted on the front of the store in a prominent manner so there will be no mistaking their location to any one happening in that vicinity.

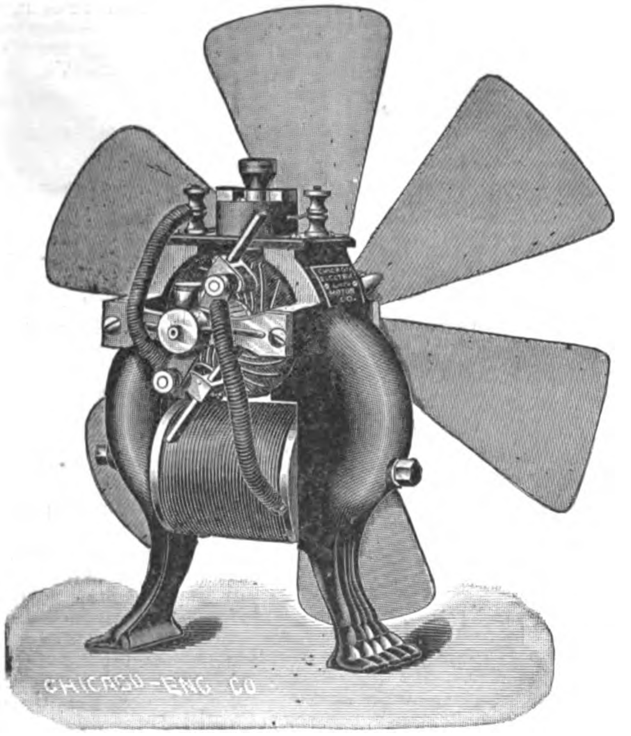
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The successful advertiser sets people thinking, talking—and buying.

THE CHICAGO FAN MOTOR.

ONE of the latest and handsomest little fan motors brought out, is shown in the accompanying illustration, which represents a 1/6 h. p. machine. A modified Gramme ring armature of the most efficient form is employed, and it is made of specially strong and durable construction, the conductors being insulated from the core and from one another in the most thorough manner, rendering a burn-out impossible. The field magnet core is of the best soft wrought iron, and is wound with a single magnetizing coil. The core is united at each end with one of the pole pieces which are of a high grade of cast-iron, and are extended to form feet upon which the motor stands. The switch for turning on and off the current is placed on the top of the motor. The 1/6 h. p. machines are wound for 110 to 500 volts, and carry a 12″ to 15″ fan. The 1-12 h. p. machines are wound for 110 volts with 11″ fans, and all sizes can be wound for any voltage desired, if so ordered.



THE CHICAGO FAN MOTOR.

These motors were designed by Mr. B. D. Sothard, and are manufactured by the Chicago Electric Motor Co., of which he is president and manager. This company also builds both motors and generators of all sizes for any class of work. The fan motors are very neat, durable, and efficient, and the workmanship is first-class in every detail.

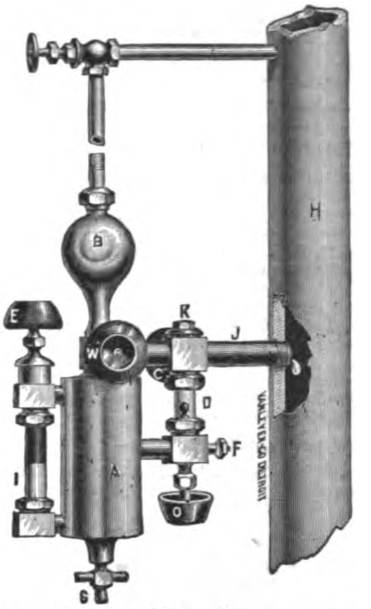
THE BALL ENGINE CO.

Owing to the great increase in the demand for automatic cut-off engines, the Ball Engine Co., of Erie, Pa., are now erecting a large addition to their works, which will nearly double the present capacity. In this extension they will set up their large engines, the building being built and equipped with special reference to heavy work, and giving unexcelled facilities for the building of high speed engines.

The company are now manufacturing their single cylinder, cross compound, tandem compound, and triple expansion engines, from 75 to 700 h. p., and also special vertical engines arranged to be directly connected to the dynamo, and suitable for use in electric lighting on ships, etc.; and it is stated that, in view of several important improvements recently designed, the engines hereafter turned out will excel anything ever built by the company in mechanical construction, economy of steam and general excellence.

THE "CYCLONE" SIGHT FEED CYLINDER LUBRICATOR.

THIS lubricator, shown in the accompanying illustration, has lately been produced by the Michigan Lubricator Co., of Detroit, Mich. As will be seen, the arms holding the glass are so arranged that the plug K may be removed at the top, and the drain valve F opened at the bottom, thus attaining a passage directly through the sight feed glass and permitting it to be renewed, cleaned, or drained, while the engine is running.



THE "CYCLONE" SIGHT FEED CYLINDER LUBRICATOR.

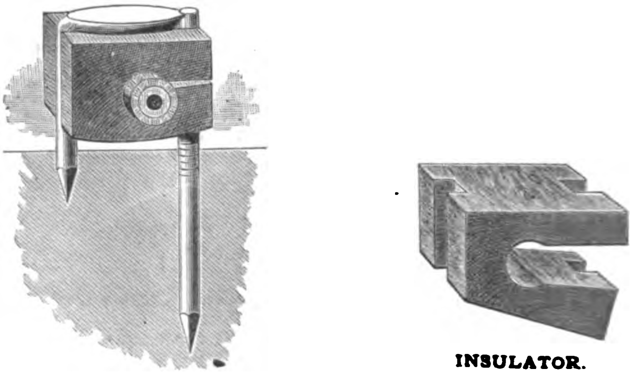
By removing the plug K, the sight feed glass may be wiped out, and at the same time filled with water to prevent waiting for water of condensation, or, if preferred, dry steam can be rushed through the glass, by closing the valve O, and opening valve C, and drain valve F, thus cleaning the glass without removing plug K.

This lubricator is finished in a variety of styles. The valve stems, packing nuts, and all parts are constructed in a heavy, substantial manner.

The cup fills rapidly, having a ¾ inch filling glass, which is vented at the rim of the filler, thus obviating much trouble and delay.

RUSH ELECTRIC WIRE NAILS AND INSULATORS.

The accompanying illustrations, Figs. 1 and 2, show an improved electric wire nail and insulator made by the Rush & Gildmeyer Manufacturing Co. of 1004 Walnut street, Philadelphia, Pa. As will be seen, the insulator will hold and firmly clamp the wire without injury to the insulation, no matter how hard the nail may be driven in, and, as the grain runs across the nail, it cannot split away. This insulator is easy to put on, quick to drive, and is especially useful in corners and concealed work. It has been approved by the New York and Boston Boards of Fire Underwriters.



INSULATOR.

Showing Insulator and Nail in position, with insulated Wire secured therein.

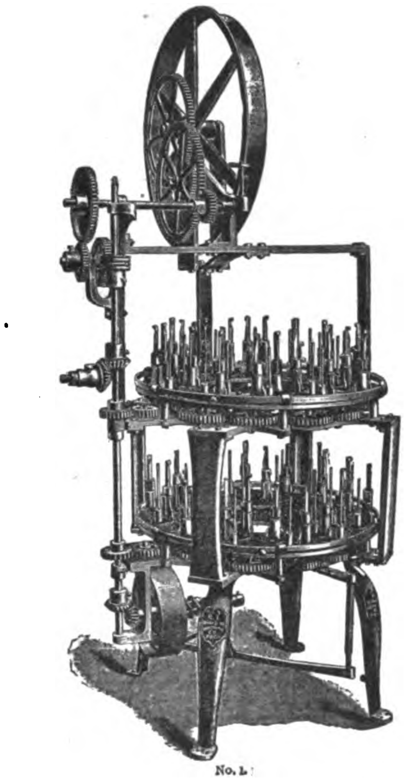
Free from all contact and firmly held.

Showing thickness of lower side, which closes up the opening as nail is driven in, and secures the wire firmly in the centre.

FIGS. 1 AND 2.—RUSH ELECTRIC WIRE NAILS AND INSULATORS.

A NEW BRAIDING MACHINE FOR COVERING ELECTRIC WIRES.

THE rapid development in electrical science, and the necessity for cables and wires covered with a suitable insulation, has opened the field for vast improvements in braiding machinery. Among the first to enter the field of manufacturing braiding machines for covering electric wires, was the Rhode Island Braiding Machine Co., of Providence, R. I., who have devised a number of useful machines for electrical purposes. We illustrate in the accompanying engraving their most recent production, which is well calculated to fill the wants of all manufacturers of insulated wire. The engraving represents one of their double braiders, with two sets of bobbins, 24 bobbins being in each set, and which is provided with a wheel take-up. This machine will cover the heaviest sizes of wires with two layers of insulation of 24 strands each.



RHODE ISLAND NEW BRAIDING MACHINE.

THE HOGGSON NEW SINGLE MAGNET BELL.

IN the manufacture of electric bells. although it may at first sight appear as though finality in simpleness of construction and reliability of operation had been reached, this is not the case and new improvements are continually being made. The new Hoggson bell, illustrated in the accompanying engravings, is seen to present some novel and advantageous features. Figs. 1 and 2 show the bell as finished either in square or round case.

HOGGSON SINGLE MAGNET BELL.

The armatures and magnet cores are coated with Banca tin to prevent corrosion. The armature springs are of German silver with platinum points, and the frames are japanned and so formed as to offer no inducements to insects.

These bells are adjusted to ring through a circuit of 200 feet of No. 18 B. & S. wire with two cells of battery, and are thoroughly well made. They are manufactured by the Stevenson-Hoggson Electric Co., of St. Louis, Mo.

THE PAISTE SWITCH SOCKET.

Many electricians have desired a socket that would carry and break 5 amperes, but heretofore this desire has never been catered to by electrical manufacturers. Mr. Paiste set to work and placed his well-known 5 ampere switch in a socket to make and break the circuit. His first attempt was not as satisfactory as he desired, the socket being made too large and unhandy to wire up. In the new style, which is just now being introduced, the socket shell is greatly reduced in size, making it the smallest socket on the market. Great care and attention was given to the manner of connecting the wires. By an ingenious device the wireman can use his discretion between a binding post and a binding screw. When in the act of wiring, both shells can be removed from the socket, leaving a clear, unobstructed place to work. By means of a yoke and collar the socket can be securely fixed to a chandelier, and under no circumstances can the shell short circuit the wires. All insulating parts are made of Syracuse china, insuring a perfect insulation. Central station men should appreciate this socket, as, by its use, one can, during the Christmas festivities, substitute large candle power lamps for the normal ones, without fear of destroying the working parts of the socket. Although not a cheap socket to make, through the agency of special machinery, it is offered in competition with those now on the market.

A PITHY TESTIMONIAL.

The Jerome Kidder Manufacturing Co. are in receipt of the following :—

NATIONAL SURGICAL INSTITUTE,
96, 98 AND 100 SOUTH PRYOR STREET, ATLANTA, GA., April 16, 1891.

JEROME KIDDER MANUFACTURING CO.,
820 BROADWAY, NEW YORK.

Gentlemen:—Please send us by Adams Express a No. 5 tip cell battery. We have been using one of these bought by our Dr. Kenouff, in 1887, and it gives more satisfaction than any other we have ever used, and we have tried several.

We are yours, very truly,
NATIONAL SURGICAL INSTITUTE, ATLANTA, GA.
Per R. H. BOLAND, M. D.

DETROIT TRADE NOTES.

MR. F. H. BLADES, of the Detroit Motor Company, reports the company as snowed under with orders for their well-known motors, and has a desk full of letters and dispatches calling for all sizes.

THE DETROIT ELECTRICAL WORKS during the past week have booked the following orders :—15 motors equipments for Lawrence, Mass.; 5 for Bristol, Tenn.; and 5 for Athens, Ga. They have just brough out a ⅙ h.p. fan motor wound for 500 volts, and operating in their offices from the street railway circuit to perfection. The little machine is quite a novelty in its line being, we believe, the first machine of such small size wound for so high a tension.

THE COMMERCIAL ELECTRIC CO. have issued a new catalogue of generous proportions and handsome typography. It contains cuts and description of almost every supply article imaginable. The book comprises some 300 pages, the first part being devoted to incandescent electric light supplies. Then follow arc lighting appliances, construction apparatus, miscellaneous tools of all kinds, wires and cables, and electric street railway supplies of every nature. A complete system of code words for facility in ordering goods by wire is a noticeable and most useful feature. A copy should be in the hands of every consumer of electric supplies.

THE COMMERCIAL ELECTRIC CO. are very busy in their construction department, they are building a 200 arc and 1,000 incandescent plant for the Western Electric Co., of Chicago, in Oil City, Pa. They are also going to build a plant for the village of East Tawas, Mich., and are now equipping the Hudson Building, Detroit, with a plant of 200 arc lights and 200 incandescents. In addition to the above they have several large and important contracts on hand.

THE FIELD ENGINEERING CO., Central Building, Liberty street, N. Y., have issued, in pocket folder form, some very interesting and useful data relative to electric railway work. Some of the figures should be in the memory of all who do construction work or are buying plants.

ST. LOUIS TRADE NOTES.

The American Electric Lamp Co. is the new name of the former American Electrical Mfg. Co., whose factory and office are located at 2011 to 2017 Pine street. The reason of their change of name is that they will now make a specialty of incandescent lamp manufacture and put a new perfected lamp on the market.

The Shultz Belting Co. are meeting with excellent success with their new link belt, which is giving first-class satisfaction on street railway work, as evinced by the strong testimonials for it that they are receiving. Their pulley covering is also having a large run, working with the most desirable results.

The Mid-Continent Mfg. Co., through their energetic manager, Mr. S. W. Baird, are pushing their well-known Brazelle governers for slide valve engines, and meeting with first-class success. These governors when placed upon an ordinary engine, govern the speed under the widest variations of load, and have only to be seen in operation, to be appreciated. An ordinary engine furnished with one of these governors, becomes self-regulating in speed for the most severe electric light and street railway service.

Mr. William H. McKinlock, of the Central Electric Co., of Chicago, Mr. Henry D. Stanley, of the Bridgeport Brass Co., of Bridgeport, Conn., and Mr. W. C. Bryant, manager of the Bryant Electric Co., also of Bridgeport, were visitors to St. Louis last week.

The Triumph Compound Engine Co., of Cincinnati, are introducing the Eickershoff patent valveless compound engine. The novel feature of this engine is the entire absence of valves in the ordinary sense of the word. The pistons themselves act as valves. The engine is of the upright type and has three compound single acting cylinders each cylinder having a high pressure and low pressure piston. The cranks are set 120 degrees apart, there is, therefore, no dead centre, the engine is perfectly balanced and will start from any position. Close speed regulation under wide variation of load is effected by a simple form of governor. The company have been quite successful in introducing their engines throughout the States and foreign countries. Many testimonial letters from electric light companies, and others have been received by the company. An extensive order has lately been received from Pittsburgh. Mr. Geo. W. Candle, No. 423 Washington Avenue represents the interest of the company in St. Louis. A number of contracts have been effected by him in this vicinity lately.

The Unicycle Elevated Railway Co.—It will be remembered that this company exhibited a small unicycle car at the St. Louis Exposition last fall, which created a widespread interest. The track on which this car was operated was perfectly straight and without grade and did not show the invention to its best advantage. During the past winter the company have constructed a full size car and elevated track with curves and grades so as to show the operation of the system under more crucial conditions. At the headquarters of the company, the old real estate exchange on Seventh street between Chestnut and Market, they have erected an elevated double track some 300 feet in length having compound curves of 10 feet radius, and grades of 5 per cent. The car and roadway are constructed on substantially the same plan as was described in **The Electrical Engineer** of October 8, 1890. The car is 16 feet in length and 6 feet wide, mounted on two unicycle trucks. Each truck is provided with two Sprague motors of 3 h. p. each, located on each side of the truck below the floor of the car. The motors are attached rigidly to the truck frame and are geared by single reduction gears 7 to 1 to the main driving wheels, which are 36 inches in diameter. The fields of the 4 motors are constantly excited. Current is admitted to the armatures through a regulating rheostat. The current at 220 volts is supplied by the St. Louis Electric Power Co., double trolley wires are used. The total weight of the car is about 7,000 pounds and it has a seating capacity for 20 persons. The work is now completed and the car in successful operation. The car passes around the short curves with perfect ease and safety. The exhibit is attracting the attention of all classes, capitalists and railroad people especially.

THE CENTRAL ELECTRIC CO, CHICAGO.

The Central Electric Company have their stores in Franklin street full of paper hangers and decorators, cleaning house for the summer.

The Okonite Base Ball Club are getting into good shape for the summer campaign and during the Saturday afternoons in June they can be found sprinting around one of the diamonds in Jackson Park and at other times are prepared to receive challenges at the office of the Central Electric Company, where they may be addressed.

In connection with the large arc lamp installation to be placed in the new Fair building of this city, the Central Electric Company has secured the contract for furnishing the wire, and of course, will supply the celebrated Okonite. This will be probably the largest insolated arc light plant in the country.

WASHINGTON NOTES.

Newport News, Va., has accepted a proposal from the Edison Co. for a central station.

The U. S. Electric Light Co. is now using Thomson-Houston alternating system in connection with the Edison. Georgetown is supplied entirely with the alternating system.

Capt. E. S. Randall has just put in a 30 light arc plant of the Edison system at River View, his summer resort on the Potomac.

The Regents of Mt. Vernon have made arrangements to use electric light on portions of the grounds at Washington's Tomb.

Rockville, Md., will erect a Thomson-Houston alternating plant during the summer.

The New National Theatre has contracted for a complete system of incandescent lighting, both on the stage and in the auditorium. The current will be supplied by the local lighting company,

WESTERN TRADE NOTES.

The Kerites, which is the auspicious name of the base-ball club comprising the employees of the Western Electric Co., are preparing for a busy season, in which they will probably measure bats with the Okonites again, whom they defeated in their contest early last summer. They expect to have an exceptionally strong team this year, and propose to be the champion team to meet the East in 1893.

The Sunbeam Incandescent Lamp Co. are just installing a new dynamo in their lamp factory and also another of the well-known Packard vacuum pumps, which are in use by almost all the lamp manufacturers in this country and in Europe. Their business has increased so rapidly that they have had to add this new machinery to keep pace with their growing orders.

J. A. Rhomberg, president of the Dubuque Electric St. Ry., of Dubuque, Iowa, was a visitor to Chicago last week. His storage battery cars there are operating very successfully.

Geo. Cutter continues to supply high insulation for odd places by sending out generous batches of rubber tape and of Simplex paint. He finds a good field for his "Rubber Elastic Tape," which is as pure as it is black, and which, like a good veteran, holds its ground without flinching.

Mr. H. H. Patter, of Monmouth, Ill., is in the city, and reports that his Lamp Hour Recorder is giving good satisfaction in the numerous places where it is used.

The Northwestern Electrical Specialty Co., Chamber of Commerce building, Chicago, through their energetic manager, Mr. Kirkham, report extensive sales on the well-known Economic incandescent lamp and that their orders are increasing all the time in a very satisfactory manner.

Mr. Jenkins, manager of the Omaha office of the Pond Engineering Co., is in town and will probably spend some time here, assisting Mr. Albert Blanchard, manager of the Chicago office, on the numerous contracts that he has in hand.

The Great Western Electric Supply Co. are doing a large business, and orders are coming in in good shape. The demand for the new Sun arc lamp for incandescent circuits is large, and inquiries are coming from all over. They are doing a brisk business, also, in general supplies of all kinds.

The Charles Munson Belting Co. are filling some large orders for their famous belting, which continues to give the highest satisfaction to users, for all kinds of heavy and severe work, and their belts for electric railway plants are meeting with specially favorable commendation.

The Illinois Electric Material Co. have recently been appointed general Western agents for the Russell arc lamps, which employ a circular carbon and will burn from 24 to 36 hours without renewal of carbons. They have already booked several orders for these lamps.

Bowers Bros., 121 Lake St., Chicago, are supplying most of the large electrical manufacturers with mica, of which they carry a large stock of fine grades, both domestic and imported.

The Hay-Horn Mfg. Co. has succeeded to the business of the Walter Hay Mfg. Co., and with larger capital and increased facilities, will extend its operations. Its headquarters are at 63 South Canal street, where it will carry on its operations as manufacturers' agent, contractors, etc.

The Thomson-Houston Electric Co. report the following recent installations made by its Western Isolated Lighting Department: Thos. Kane & Co., 137 Wabash ave., Chicago, 50 light incandescent plant to run in connection with Regan vapor engine; Wm. Ruehl Brewing Co., 224 West 12th street, Chicago, 200 light incandescent plant; Hager & Johnasen Mfg. Co., Marquette, Mich., 250 light incandescent plant; Ranken & Fritsch Foundry & Machine Co, St. Louis, Mo., 18 arc plant; Morrison, Plummer & Co., 200 Randolph street, Chicago, 250 light incandescent plant.

THE VALUE OF RAW HIDE PINIONS.

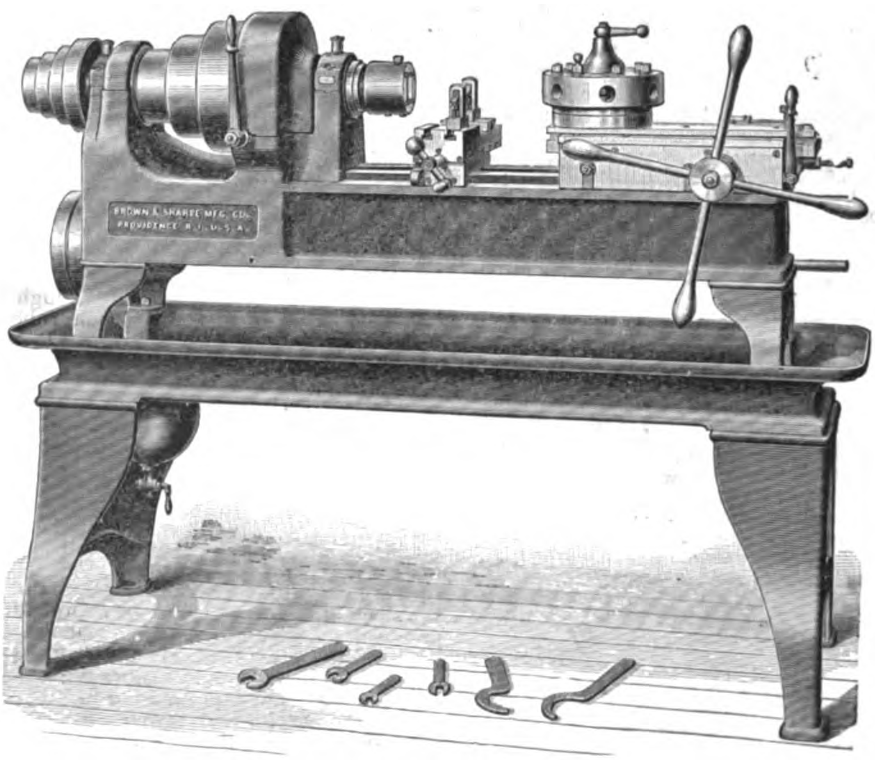
The New Process Raw Hide Co., of Syracuse, N. Y., are in receipt of the following from the Pleasant Valley Road, of Pittsburgh :—

I write to let you know of our continued success with your raw hide pinions. Have had them put to most severe tests on 12½ per cent. grades and find that they stand the work admirably. They will outwear steel and iron pinions, and are superior to bronze in many respects. Can especially commend your new "flange" pinion to roads having long or steep grades. We have tried *every* make of pinion known, metal and otherwise, and can say without any qualification that New Process Raw Hide has no superior.

Sincerely,
(Signed) WM. McC. RAMSEY.

THE BROWN AND SHARPE SCREW MACHINE.

The accompanying illustration represents the No. 6 screw machine, made by the Brown and Sharpe Mfg. Co., of Providence, R. I. This machine is suitable for making studs, screws, and a large variety of small parts of machines from the bar, also for finishing work held in a chuck when several tools are required or a number of operations are to be performed.


BROWN & SHARPE MFG. CO.
PROVIDENCE R.I. U.S.A.

BROWN & SHARPE NO. 6 SCREW MACHINE.

The head is back geared and the change from belt speed to back gears is effected, without stopping the spindle, by a friction clutch which is practically positive in its action and will hold the full belt power of the machine. The "back gears" are underneath the spindle cone and are entirely enclosed, as are also the gears on the cone. The cone has three steps, 6", 8¼", and 11" in diameter, and the back gears are 4.63 to 1.

The spindle is steel. Its front bearing is hardened, and both bearings are ground. It has a hole 1 7/16" diameter, and the front end is fitted for a chuck. The end thrust is taken by the rear box, and received directly on a hardened steel nut and washers. The spindle boxes are 2¼" and 2 13/16" diameter, 3 13/16" and 2 13/16" long. They are steel, hardened and ground. Number of revolutions of the spindle to 1" of movement of the turret head for each step of the feed cone, 50 and 96, 39 and 76, 29 and 52, and 21 and 36.

The turret is fed automatically, or by hand, and has eight speeds, as each of the four speeds given by the feed cones may be varied by shifting a lever, so that, without changing the belt, the tools may be fed fast or slow for each step of the cone. The turrett is 9⅛" diameter and has 7 holes 1¼" diameter. The movement of the turret head slide is 9⅝", and the extreme distance between the face plate and the turret is 32". The length that can be drilled, or milled, without moving the turret head slide bed, is 6".

The swing over the tool post slide is 6¼". Swing over bed, 18⅛", and length of bed, 56".

The counter-shaft has friction pulleys 14" in diameter, 3½" face, and should run about 175 revolutions per minute.

The floor space occupied by this machine is 30" × 78", and its entire weight is 1,800 pounds.

BALTIMORE ELECTRIC REFINING CO.

The new buildings for the Baltimore Electric Refining Co., at Baltimore, Md., will be made of iron designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn. The rolling mill will be 56 feet in width by 180 feet in length. The refinery building will be 180 feet in width by 80 feet long, and the boiler house will be 49 feet in width by 50 feet long. The buildings will be entirely of iron, no wood work being used about the construction in any way.

PAGE BELTING CO.

The Page Belting Co. report recent orders filled as follows :— A complete outfit for the Beaumont Furniture & Art Wood Manufacturing Co., Beaumout, Texas, including a belt 20 inches wide, also a complete outfit of belting for the Mohawk Knitting Co.'s new mill at Mohawk, N. Y., and a complete outfit for the Pennsylvania Steel Co. at Sparrows Point, Md. Among the special belts of their make for running dynamos, shipments have been made during the last month to J. A. Grant & Co., Portland, Me.; National Sewer Co., Newport, Ohio; Forbes, Liddell & Co., Montgomery, Ala., and the Electric Forging Co., of Boston. Among the large main belts furnished have been belts to the Des Moines Manufacturing & Supply Co., Des Moines, Iowa; to the McNeil Pipe & Foundry Co., Burlington, N. J., and to Gaines & Glover, Richmond, Va.

MR. CHARLES A. BROWN, manager for the Western Electric Company, Chicago, having graduated in law a year ago, is about to sever his connection with manufacturing and commercial business. He has formed a partnership with Mr. George P. Barton, of Chicago, to conduct a general law business, making a specialty of patent law and allied branches of practice. The new partnership will go into effect July 1, next.

THE EMERSON ELECTRIC MANUFACTURING CO., of St. Louis, are now working night and day turning out their numerous lighting and railway specialties and their new alternating fan motors which have only to be seen to be appreciated.

MR. F. A. ROSS has resigned as manager of the Livingston Electric Light Co., of Livingston, Mont.

"THE ELECTRICAL ENGINEER" IN PHILADELPHIA.

Owing to the rapid growth of electrical industries in Philadelphia, and of the business relations of THE ELECTRICAL ENGINEER with that city, this paper has established an office there at 714 Girard Building, Broad and Chestnut streets. This office will be in the charge of Mr. Wilbur F. Hanks, who is already very favorably known in that section in connection with electrical journalism, and Mr. Hanks has now entered upon his new duties. In making this announcement, THE ENGINEER asks, with confidence, that its many friends and readers upon whom it will be Mr. Hanks' pleasant task to wait, from time to time, will favor him with full and early news, so that the interests of his territory may be thoroughly represented in its pages.

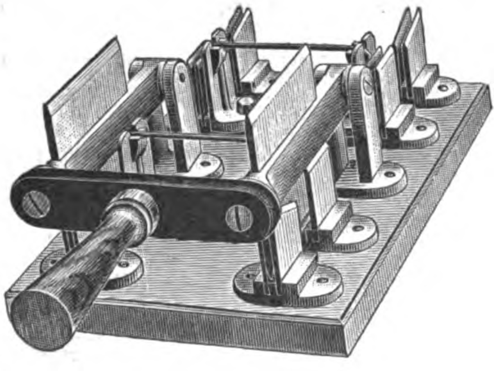
PHILADELPHIA NOTES.

H. T. PAISTE, the enterprising electrical specialty manufacturer, of Philadelphia, recognizing the want of a store room and office in Chicago, has opened out at 341 The Rookery, that city, where his Western friends and patrons can be supplied without having to order from the factory in the East. The move seems a popular one among the supply men of the West, as it will save them the necessity of ordering in large quantities to save freight and express rates. Mr. Paiste still continues his Eastern office and factory at 1201 Market street, Philadelphia. The Western office will be managed by Messrs. Kohler Bros. and Grier, three enterprising young men, who will do all in their power to cater to the wants of the Western electrical trade in Mr. Paiste's line of specialties, which consists of porcelain base switches, china switches (which are decorated in all tints to match wall paper), sockets, cut-outs and gas attachments.

MR. S. ASHTON HAND, of Philadelphia, a widely known mechanical engineer, member American Society Mechanical Engineers, and lately general superintendent for Morris, Tasker & Co., has joined the forces of the Equitable Engineering & Construction Co. Mr. Hand will take entire charge of the mechanical engineering department of the Equitable Co., whose offices are in the Drexel Building, Philadelphia.

THE "BAGNALL" FUSE SWITCH.

THE demands of the electric railway service call for some automatic device which will afford absolute protection against excessive current in the feeder wires, and which can be readjusted without loss of time. For this purpose the circuit breaker of various forms has been employed, and while it has many advantages over the ordinary form of fuse block, nevertheless, on account of the mechanical nature of the device, it is liable to fail in its operation by sticking or getting out of adjustment.



BAGNALL FUSE SWITCH.

The Bagnall fuse switch, made by the Emerson Electric Mfg. Co., of 518 Elm St., St. Louis, Mo., embodies the certainty, simplicity and cheapness of the fuse with the convenience of the circuit breakers.

It is a combination of a fuse block and a switch, having a double or relay fuse which can be thrown in instantly when the first fuse melts. The fuse, which is the ordinary fuse wire bent into U shape with the fingers, is inserted in the fuse block without the use of any screw-driver or other tools, and the contact is automatically made and the fuse firmly clamped when the switch is thrown in. It is the work of but an instant to put in the fuse, and all danger of premature fusing is prevented, as the fuse terminals are completely isolated and disconnected by the opening of the switch.

Two styles of these switches, a single and a double, are made. The latter, shown in the accompanying illustration, provides a relay fuse, always ready to be thrown in. They are substantially made, on polished slate bases, and are valuable adjuncts to the operation of central power and lighting stations.

Financial Market.

THE OUTLOOK FOR ELECTRICAL SECURITIES.

Nothing frightens purchasers of stocks and investment securities more than large exportations of gold. Speculation has been from time to time almost stopped by the heavy demand made on this country for gold on foreign account. At this time, however, while the demand from abroad has been especially great, people are beginning to realize that this country is the only one at present in position to supply gold, and the market is thereby strengthened. Our ability to supply the precious metal has had the effect of making England a heavy buyer in our markets. That country has rarely shown the confidence in American securities that they deserved, and America in turn has given too much attention to English demand, when it came, for our stocks and bonds. The market here has many a time been thrown entirely off when every indication was favorable to the purchase of stocks, by the large selling orders from London. The present condition of affairs would indicate that independence of such foreign influence is tending to the betterment of our own securities.

Apparently everything is ripe at the present time for an upward trend of the market. A temporary reaction may come, but it will not hinder a general rise in the market for any great length of time. The condition of the crops is good, and we are happily free from any immediate Congressional legislation.

One of the best evidences of the strength of electrical stocks is found in their activity during a depressed condition of the general market. Few stocks stood as well during the panic, and few indeed have been the railroad shares that showed so little depression during the last few weeks.

Generally speaking, the electrical stocks that are listed are dividend paying stocks, and it is hardly possible for them to fall like some of the so-called "fancies" on the New York Exchange. Generally they represent good investments, and at present prices may be considered cheap. These stocks are better understood and appreciated now than ever before.

Bonds on electric railways in large issues, in cities of 40,000 population and upwards, are finding a ready market, but bonds in small issues, representing small street railways, are very difficult to sell. Banks and trust companies, not having special facilities for examining these securities, are seldom attracted by them, unless the price is considerably below par for small issues. Another reason for the slowness with which these small bonds are marketed is demonstrated by a procedure similar to this: A couple of promoters succeed in getting a franchise to run an electric railway through a small town. It needs but a small expenditure of money to obtain the franchise, the company is formed and the stock of the corporation put into the pockets of the promoters, practically costing nothing, and the bonds are issued to pay for the building of the road. If the road can pay operating expenses and interest on the bonds, all is well; if not, the bondholders have only a secondhand road for security, and not being able to get out what they put in, will cry out with all their strength against electrical securities in general.

There are as good opportunities to make large profits in electrical bonds as can be had in any market. It is an easy matter to sort the good from the bad, and none but the best investments need be taken up. Electrical bonds can easily be found whose security is undoubted, and these bonds can be had at from 90 to 95, whereas railroad bonds, with no better security, sell for par.

The market for electrical stocks has been active during the week. Edison stock has strengthened and closed at 100 bid, 102 asked. Thomson-Houston has been steady, closing at 44 bid, 44¼ asked. Bell Telephone closed at 199 bid, 200 asked, and is likely to see a rising market in a very short time. At the present price Bell Telephone stock can well be considered cheap. Westinghouse fell slightly from last week, but will likely recover during the coming week. The stock closed 14 bid, 14⅛ asked.

FRANCK Z. MAGUIRE.

THE CONDUIT WIRING CO.

The above company have started in business at 12 West 29th street as electrical contractors, and with special authorization from the Interior Conduit & Insulation Co. to put in the conduit system. They will make the proper installation of interior conduits a leading feature of their business. They are also prepared to make contracts for complete electric light installations or for electrical apparatus of various kinds. Mr. C. J. Klein is the president and general manager of the new concern, and Mr. S. Davis is the secretary and treasurer. The latter has long been engaged in engineering work, and the former needs no introduction to the electrical community. They invite correspondence and calls at their office and show rooms.

THE
Electrical Engineer.

VOL. XI. JUNE 3, 1891. No. 161.

THE WRITING TELEGRAPH.

MANY of our readers will remember the introduction some time ago of a system of transmission called the "Writing Telegraph," which attracted considerable attention on account of its novelty, and the simplicity of its operation. The system, which was introduced by the Writing Telegraph Company, of this city, consisted, in brief, of a transmitter which served to vary the current on two lines connected to the receiver. The latter consisted of a pair of electro-magnets placed at right angles to each other and acted upon an armature which followed exactly the movements of a stylus in the transmitter; this stylus served to vary the currents on the connecting lines by cutting in or out a set of resistances.

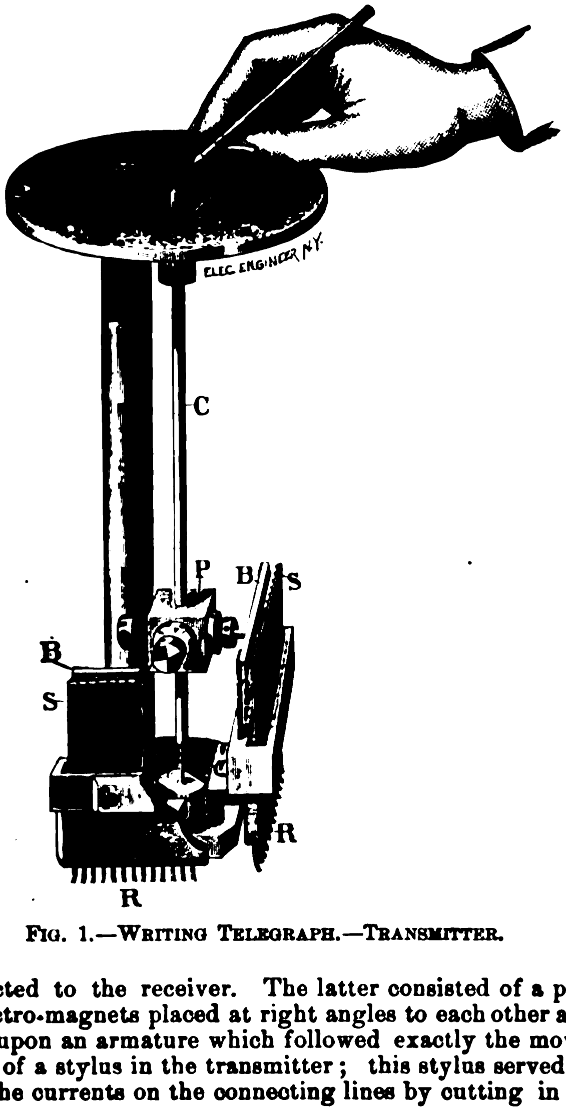


FIG. 1.—WRITING TELEGRAPH.—TRANSMITTER.

After many trials and experiments, the "writing telegraph" may now be said to be in a perfected condition, as evidenced by the work it is able to do, and which we had occasion to witness recently.

The transmitter, which fully meets all the requirements for electric writing, is the invention of Mr. Harry Etheridge. This part of the apparatus, which is shown in perspective, in Fig. 1, consists of a top plate, which rests on top of the case. A rod depends from this plate and supports the base. Secured to this base, and arranged at right angles to each other, are two receptacles, in which two series of steel spring tongues, S S, are separately held in a vertical position by an insulating cement.

The spring tongues are placed in line with each other, edge to edge, with a sufficient space between them to avoid contact. They are also hardened and tempered so as to readily return to their normal position, after pressure on them is released. To the lower end of these tongues a series of resistances R are secured, while their upper ends are provided with platinum contacts.

Supported from each holder by two spring strips, which are insulated, is a brass contact bar B, having its side next to the steel tongues and arranged at an angle thereto. These two contact bars are each provided with a platinum wire placed opposite the platinum contacts of the spring tongues, and by reason of their spring supports can be brought in contact with the tongues, each tongue making contact independently of the rest.

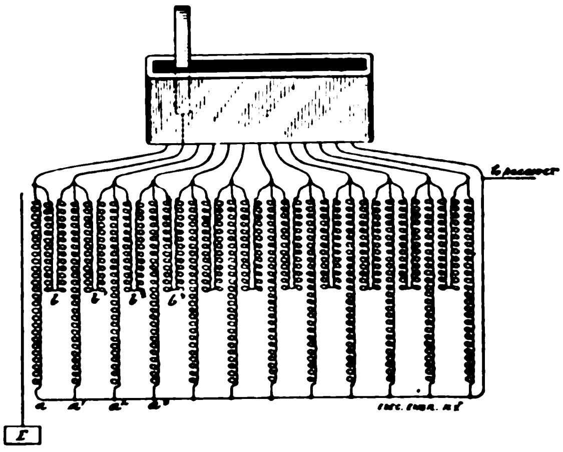


FIG. 2.—ARRANGEMENT OF RESISTANCES IN WRITING TELEGRAPH TRANSMITTER.

The stylus rod C is screwed into the base, and its spring at the lower end allows of a free movement of the upper end in any direction. A pressure block P, as shown, is secured to the stylus rod. Two adjustable pressure heads are screwed into this block and held tightly by locknuts in whatever position adjusted.

When the stylus is in its normal position, the pressure heads are so adjusted that contact is made with the projection on the contact bar, and the contact bar with the first spring tongue, whereby any lost motion is prevented.

When the stylus is operated, the contact bar is pressed against the tongues, making contact with a greater or less number, according to the extent of movement of the stylus, thus cutting in, or out, the resistances required to regulate the movement of the receiving pen. The resistances are arranged to avoid any break of circuit or oxidation at the contact points.

There are two series of resistances employed for each set of tongues and both connected to them in the manner shown in Fig. 2. One a, a^1, a^2, etc., is arranged in parallel arc, the other b, b^1, b^2, etc., in series, and both combined. The resistance of a^1, measured in ohms, is the same resistance as b. The resistance of a^2 is less than the resistance of a^1 but is the same resistance as b^1, and so on, the resistance continuing to decrease from a maximum resistance arranged farthest from the receiver to a minimum resistance; the last tongue to make contact with the contact bar controlling the lowest resistance.

The operation is as follows: When the tongues are out of contact with the contact bar, the current circulates in every branch; being of course, proportional to the resistance. When, through the movement of the stylus, the contact bar touches tongue No. 2, the resistance a^1 is placed in parallel arc with resistance a, while the resistance b, of resistance equal to a^1, is practically electrically cut out. The resistance b therefore prevents an open circuit in a^1 when contact 2 breaks contact with the contact bar, balancing the resistance a^1. In other words, the resistance b offers another and equivalent passage for the current the moment a^1 is separated from a, and so on throughout the remainder of the arrangement of resistances.

This transmitter has been used in commercial work with heavy battery for months and has never required touching. It has been tried in every style of work expected of the system and been found reliable.

Twelve contacts give all the variation required for any length of line. A parabolic curve, Fig. 3, describes the curve of resistances, and the same curve is used for all lines. The current used varies from a minimum of .0165 to a maximum of .03 of an ampere.

The receiver, which is shown in Fig. 4, has been changed, as shown in the cut, so that the only adjusting screws about the apparatus are one for each magnet, and these raise or lower the cores to or from the armature, when being adjusted to the line. The double armature, magnetically connected, and the float employed to remove the tremor of the armature rod, are retained. There is an armature (not shown) under the cores of the magnets which releases the paper-moving mechanism. Under the top plate of the transmitter are contacts which automatically cut out the transmitter when the stylus rod is released—and also a contact for calling up when placed in an exchange system.

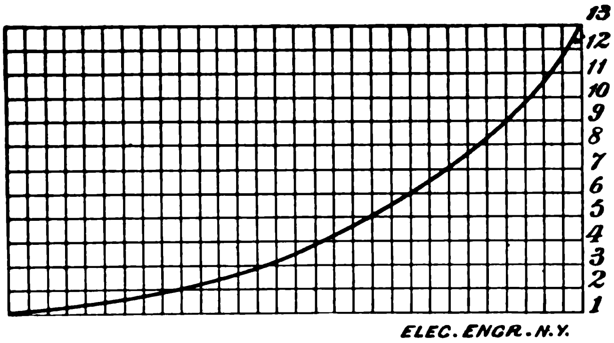


FIG. 3.—CURVE OF VARIATION OF RESISTANCES.

The greatest distance over which the instruments have thus far been operated was between New York and Pittsburgh on May 3, the distance being 468 miles; the wires were of copper, No. 12 (Stubbs) gauge, and the resistance was 2,550 ohms. The current used was from a test dynamo of 100 volts. This was all at the Pittsburgh end, and fed to both lines.

The insulation resistance should have been 12,000 ohms on each line, but, on account of the rain, this resistance on one line measured 6,700 ohms, and on the other 5,200 ohms. Notwithstanding the great loss of current thus incurred, there was the usual ease and speed in writing. The test showed to good advantage this manner of writing, as the stylus rod is always moved sufficiently for the receiving pens to form a perfect letter. Any variation of the battery or resistance on the line is overcome automatically by the operator unknowingly pressing his stylus rod laterally or downward, as the case may be, an infinitesimal fraction of an inch, to cut out the necessary resistance to form a perfect letter; the reproduction will evidently be a corresponding duplicate at the other end of the line.

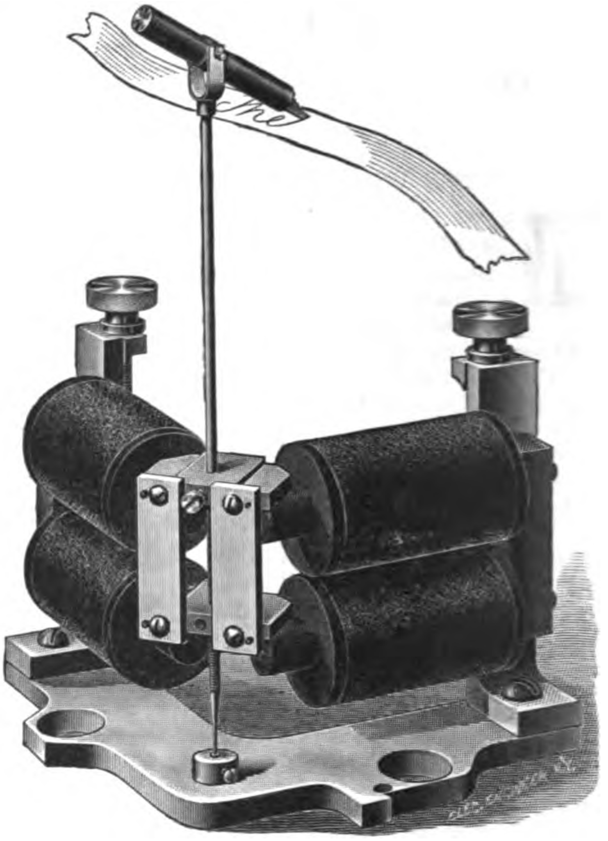


FIG. 4.—WRITING TELEGRAPH.—RECEIVER.

The test of operating between New York and Pittsburgh has convinced the company that they can write with the greatest ease over much longer lines and without relaying.

COST OF POWER TRANSMISSION.

THE following comparisons of the cost of transmitting power by various methods appeared in the *Revue Universelle des Mines*: 1. Comparative cost on 10 e. h. p., transmitted 1,093 yards: by cables, 1.77; by electricity, 2.21; by hydraulics, 2.90; by compressed air, 2.98. 2. Comparative cost on 50 horse-power, transmitted 1,093 yards: by cables, 1.35; by hydraulics, 1.87; by electricity, 2.07; by compressed air, 2.29. 3. Comparative cost on 10 effective horse-power, transmitted 5,465 yards: by electricity, 2.64; by compressed air, 4.66; by cables, 4.69; by hydraulics, 5.29. 4. Comparative cost on 50 effective horse-power, transmitted 5,465 yards: by electricity, 2.37; by cables, 2.65; by compressed air, 2.99; by hydraulics, 3.02. Steam was the prime motor used in each of the above instances, and it appears that for long distances electricity takes the lead in economy over all other systems.

FRANKFORT EXHIBITION.

THE Grand Duke of Weimar has lent the Exhibition authorities the electric machine with which Goethe made his experiments, and which is included in the relics in the Goethe Museum at Weimar. The Congress of German Municipal Authorities, to be convened by the chief magistrate of Frankfort during the Exhibition, is to be held on August 27th, 28th, and 29th. The two electrical boats which will be on the Main during the Exhibition are to be accompanied by a boat propelled by a petroleum engine. The engine will also drive a small dynamo which will generate current for the lights.

ELECTRICAL ENGINEERS.

ALBERT SCHMID.

Mr. Albert Schmid, the subject of our portrait this week, is a native of a country famous for its mechanical wonders and engineers, having been born in Zurich, Switzerland, in the year 1858.

Mr. Schmid received an elementary education in the well-known schools of that town, and at the age of 14 entered the shops of one of the largest Swiss engineering firms, where he remained five years, going through all the departments, including the drawing office, as well as erecting machinery for this firm throughout Europe, thus receiving a thorough practical engineering training. Leaving this establishment, at the age of 19, a skilled mechanic and competent draughtsman, Mr. Schmid entered the celebrated Swiss Engineering University of his native town, from which he graduated two years later with a splendid equipment of theoretical and practical knowledge, which he has since used to such good advantage. He then associated himself with Carrels Brothers, the well-known Belgium locomotive builders of Ghent, where he was employed for some time designing locomotives, Sultzer engines, and in general engineering work. Desiring to get a broader experience, he next engaged with the renowned engineering firm of Easton & Anderson, of London, England, in the same capacity. By his work here he established a reputation which attracted the attention of a well-known French electrician, who induced Mr. Schmid to become connected with him in some electrical experiments for the Westinghouse interests in Paris. After completing this work he was brought to this country in 1884 by Mr. George Westinghouse, Jr.

Albert Schmid

The Westinghouse Electric Co. was organized about this time and Mr. Schmid was made superintendent, in which capacity he still serves that company. In this position Mr. Schmid's varied experience and thorough training has had an opportunity to demonstrate itself, the mechanical design of the apparatus manufactured by the Westinghouse Company bearing excellent testimony to his ability and knowledge of electrical matters.

Mr. Schmid's executive capacity is displayed by the perfect system with which the Westinghouse Company's shops at Pittsburgh are laid out and operated.

He has kept well up with the vast strides made in electrical science in the past decade, and, being endowed with considerable inventive talent, has contributed largely to the electrical perfection which the Westinghouse apparatus has attained.

Mr. Schmid has taken out a number of valuable patents, many of which, on electrical subjects, are controlled by the Westinghouse Electric & Manufacturing Company, besides which he holds a number of various mechanical devices. His new gas engine was illustrated in these pages **a few weeks ago.**

Mr. Schmid is a member of the American Society of Mechanical Engineers, as well as of the American Institute of Electrical Engineers.

LEAD COVERING FOR ELECTRICAL CONDUCTORS.

BY

L. D. [illegible].

To anyone unaccustomed to lead working it may seem the easiest thing in the world for a metal like lead, which is so easily melted, moulded or hammered, to be forced around a core bar and through a die for the purpose of making lead pipe.

Given the conditions of unlimited power and space, it might perhaps be an easy matter, but brute force is not science, and on scientific principles alone, is economy possible either in construction or production. Economy is the ruling factor in all commercial processes, and power and space are two of the most important elements on the reduction of which, to a minimum, success will greatly depend. The efforts of inventors have, during the last few years, been energized in this direction, with the result that lead covering machinery has been greatly reduced in size and weight, and the power required to drive it diminished, but it has, unfortunately, also become more intricate and sensitive.

Lead, though apparently so easy a metal to handle, is really one of the most sensitive to slight changes of mechanical working conditions when under high temperatures. That it melts and becomes very fluid at about 600° Far. is well known; but just at what temperature it is neither fluid nor solid, but only fit to make pipe, is a matter of considerable uncertainty. At its plastic point, or when just hot enough to make pipe easily, a very slight change in temperature will create a very considerable change in its condition, so much so, that the pressure required to force it through the die will vary from fifty to one hundred per cent.

The right temperature can only be got at by "rule of thumb," or by the negative process of finding out what is the wrong temperature. An old pressman whom I questioned on this point replied : "I don't know when I've got the right heat, sir, but I knows when it't too hot and when it't too cold, so I steers between the two." And this, I think, embraces the philosophy of the whole science of pipe making.

It is true that all doubt and possible failure on the question may be avoided by making lead pipe from cold lead, but this is a return to first principles, and is never done save when, as in the case of covering electrical conductors insulated with gutta percha, or some similar gum or compound, and which melts at less than 212°, the hot lead process is inadmissible. Of course to make pipe by the cold process necessitates great pressure and involves very heavy and powerful machinery.

By the hot lead process the pressure required is about one-tenth, and the weight of the machinery and power correspondingly diminished. Among other peculiar properties, lead possesses the greatest possible objection to being drawn over itself, hence, perhaps, the reason of the great power required to create its flow when plastic, so as to convert its solid mass into hollow and comparatively thin pipe. Anyone who has tried to take up the slack of a lead covered cable, even when cold, by drawing it over the other coils on a reel or drum, will have noticed this. It is almost impossible to do so, whereas with iron or brass it would have been easy enough.

To make lead pipe alone by the ordinary overhead press is a process requiring much experience and close attention, but when it is required to lead cover electrical conductors, the conditions are more exacting, and the difficulties increased. If a length of lead pipe is spoilt by accident or carelessness, which, however, but very rarely happens, it is simply returned to the melting pot, and the loss incurred is only that of labor and fuel, but in the case of covering such conductors as, say, a telephone cable, the result of an error is that the cable is either spoilt entirely, or at least has to be withdrawn from the press, stripped of its lead and the whole process commenced "de novo," a tedious, expensive, and dangerous piece of work.

There is a modification of the cold lead process by which conductors have been covered of late years to a considerable extent with more or less success. It consists in drawing the cable through short lengths of pipe which are afterwards jointed with an ordinary plumber's "wiped" joint, but it embodies so many disadvantages that it has fallen into very just disrepute. It is impossible to so cover more than very moderate lengths of cable; the joints are always weak places, require the best of skilled labor, and they take up valuable space. Besides this, as the pipes must be large enough to admit the cable to be drawn into them without excessive strain, which might damage it, the conductor cannot possibly be concentric with it, and thus a larger pipe than is really necessary is unavoidable.

When, however, the insulating material employed is one which has a high melting point, or, as in the case of fibrous insulation, no melting point at all, the hot process is the only one commercially practicable.

It does away with intermediate joints, may be made to cover cables of any length in one piece, and can also be designed to fit the cable so exactly that moisture is excluded without undue pressure on the insulation.

The machinery required is very simple. The cable is passed through a hollow core bar and a die which are seated in steel "blocks." These blocks are provided with an opening on the top, through which lead is forced by hydraulic pressure from a "lead cylinder" around the "core-bar" and through the "die," and thus becomes pipe, which on its way fits closely enough on the cable to drag it through the blocks, from which it emerges lead covered.

But whether the lead is put on by one or the other process there can be no doubt that it is surely working its way to the front rank as a cable covering. For submarine work, of course, it is out of the question, and its place is taken by lighter hemp and more flexible wire armoring, but for all other purposes it is recognized as the best, if not the only absolute, protection for electrical conductors, more especially for underground work.

In the early days of its adoption, specifications required that lead covered cables should be placed under water for at least two days and nights and then tested. The writer remembers one specification calling for immersion under water for a stated time, one end of the cable to be hermetically sealed and the other attached to an air pump. Air was then forced in so that escaping air bubbles or their absence decided the refusal or acceptance of the cable. But experience has proven all such tests to be unnecessary with the hot lead process, and like plumbers' and gas fitters' pipe, cables are now accepted with their lead covering as perfect, without the formality of other than the ordinary electrical tests. That this may be done with perfect security is evident from the very nature of the process.

The pipe must be either perfect or absolutely bad. Neither cracks, pinholes, nor other hidden faults are possible with a soft metal like lead, which, when heated to something less than melting point, is submitted to a pressure ranging from four to seven hundred tons. If there is a fault, it is flagrant and unavoidably perceptible. It may arise from the lead being too hot or the pressure too sudden, in which case a blow-out or "squirt" happens and the pipe is severed with a gaping, ragged edge.

Or, if the cable is hauled on too strongly and allowed to pass through the blocks faster than the pipe is formed, the latter will either be reduced in diameter, or, which is more probable, it will be torn apart; in either case it is impossible for such a fault to pass unnoticed.

The only other case which has ever happened in an experience of some thousands of miles of conductor, is cited as a curiosity rather than a liability. A small piece of the die broke off and became embedded in the pipe, from which it afterwards fell when the cable bent on the reel, and it had to be stripped and re-covered. The chance of such an accident ever recurring is too remote to be worth serious consideration.

When everything is in first-class condition the surface of the lead, as it issues from the press, should be perfectly smooth and polished, and its outline straight and cylindrical. If the cable is sinuous or "snakey" the pipe is either too large for the cable or the cable has been obstructed in its passage through the "blocks" and the pipe forced out faster than the cable has followed.

If the surface of the lead is dull and rough or tinted, it is proof that it has been made too hot, and cable so covered is more brittle and difficult to draw through a conduit than it should be if properly made. Too much heat is also indicated by the presence of minute fissures on the surface of the pipe at right angles to its length. These are, however, only on the surface, and I have known in a case of emergency, such pipe accepted and laid, and which, although exposed to the most unfavorable conditions for some years, is still giving perfectly satisfactory results. These are the only faults to which lead covering is liable. It must be admitted that they are few and within easy reach of avoidance by the use of care and watchfulness.

We may therefore conclude that under ordinary conditions, lead is practically a perfect, if not an everlasting, cable protector. It is no argument to say that lead will fail under conditions such as those of special and extraordinary chemical action, which would destroy any metal; but even there lead will hold its own, for the salts formed on the surface generally make a crust which prevents further action beneath it.

The writer has handled lead pipes which were laid down in Pompeii more than eighteen hundred years ago. Some six years ago they were in use for conveying water, to all intents as good and sound as when laid. It may be objected that no parallel can fairly be drawn between lead pipes which have lain under ashes and scoria for eighteen centuries, and those laid in our great modern cities, in conduits exposed to destroying gases and corroding effluvia. But it is a very fair comparison. Those pipes were laid underground long before Pompeii was buried, and judging from appearances, the inference is unavoidale that dirt and filth flourished there in much greater luxuriance than even in that queen of dirty metropolises, New York.

The use of lead is, after all, but a return to first principles. It was one of the first protectors of electrical conductors tried some fifty years ago, but abandoned on account of objections which, in this age of progress, vanished before improvements which render its application not only easy, but successful. Lead covering, as applied to-day, is as perfect as it is possible for anything to be, and experience only goes to confirm the idea that age in nowise impairs its protecting powers.

ON THE MEASUREMENT OF POWERFUL CURRENTS WITH A MIRROR-GALVANOMETER.[1]

BY A. OBERBECK.

By the principle adopted by the author, "the most powerful currents, without the addition of any shunt, give such small deflections that they can be measured with a mirror-galvanometer." A circuit of small radius surrounds a small magnet needle placed at or near the axis of the circle, and deflects the needle more strongly than a second circuit, the radius of which is greater. The two circuits being placed concentrically in the same vertical plane, they can be shifted to such a distance from the needle that their influences on it are equal, and if the directions of flow are opposite, the needle will remain in its normal position. By placing the circuits at a distance from the needle suitable to the strength of the current to be measured, the desired small deflection can be obtained.

CENTRAL STATION MANAGEMENT AND FINANCE.—V.

BY

Horatio A. Foster

Store Department.

The blanks for use of the Storekeeper are No. 11, order for stock, a tag for lamp, motor or transformer, in fact any article returned from outside the station for repairs or anything else; Blank No. 12, his weekly report for supplies used; No. 13, for operating, and No. 14 for construction material.

(Form 13.)

OPERATING SHEET.

Storekeeper's Report for__________ending__________189 Entered Journal, page______

Day and Date	Cubic feet Water.	Coal.	Lubricator.			Pounds Waste.	Yards Rags.	Carbons.		Globes.		Incandescent Breakage.				Sundry parts for electrical repairs				Sundry parts for motive power repairs			
			Dyn. Oil. Gals.	Cyl'r Oil. Gals.	Grease Lbs.			⅝ in. C. C.		City.		10.	16.	32.	Series.								
Sunday.																							
Monday.																							
Tuesday.																							
Wednesday.																							
Thursday.																							
Friday.																							
Saturday.																							
Total.																							
Price.																							
Amounts.																							
Totals.																							

Blank No. 13.—Storekeeper's Report for Operating Material.

(Form 14.) [illegible]

CONSTRUCTION SHEET.

Storekeeper's Report for__________ending__________189 Entered Journal, page______

	Pole or overhead lines.	Price.	Amounts.			Inside wiring.	Price	Amounts.			Station and buildings.	Price.	Amounts.	

Blank No. 14.—Storekeeper's Report for Construction Material.

The above blanks are all very simple, and with the exception of No. 13, require no explanation. No. 13 is made by the week and each day is stated, as it is then easy at any time to divide the week into any parts, as, say, when the first of a month comes on Thursday, and all other reports are made from the 1st to the 31st.

The writer advocates the keeping of a regular supply account in the ledger, to which are charged all bills for supplies entering the station, and to which are credited all supplies taken out for the business, as per the weekly reports No. 13 and 14, which can then be journalized like any other bill. When this is done it is easy to give a complete and quite accurate statement of the financial condition of the business at any stated time, say monthly, and the balance of the supply account can be tested yearly by a complete inventory of stock on hand, when any difference can be charged off. The storekeeper should also be provided with a blank receipt for goods sold outside. No special form is mentioned here, as there are many good ones already made, which can be procured at any stationery store.

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[1] *Wied. Ann.*, Vol. 42.

Order No.______

______189

Filled______189

[Form No. 11.]

Storekeeper's Order for Supplies.

*No.*______ ______*189*

______*Manager.*

Please order at once for stock.

*Signed*______ *Storekeeper.*

BLANK NO. 11.—STOREKEEPER'S ORDER FOR SUPPLIES.

[FORM 12.] Copyrighted 1891.

Sgl. *Dbl.*

Lamp No.______

Brought in______***189***

______

From______***Street.***

Circuit No.______

Trimmer______

Inspector______

Why returned:______

______

______

Repaired by______

Turned in to storekeeper

______***189***

BLANK NO. 12.—STOREKEEPER'S WEEKLY REPORT FOR SUPPLIES USED.

LEAD TUBES IN SALEM.

The telephone linemen in Salem, strung a lead tube along Front street and up Washington as far as the central office. In this tube were 65 telephone wires. These will take the place of the half a hundred now strung on poles along the same streets. The wires have rusted out very quickly the last few years from the effect of the salt air on them.—*Boston Transcript.*

STANDARD CELLS.

BY

H. S. Carhart

YOUR issue of May 20 contains an account of a new form of Daniell standard cell, by Mr. Carl Hering. It was not new to me, though just as original as with Mr. Hering, for I have one, made some months ago by two students at my suggestion. The only difference is that I use two hard rubber stop-cocks instead of wire pinch-cocks, as shown in Mr. Hering's illustration.

The effect of pressure upon E. M. F., mentioned by him, is not quite new, as may be ascertained by referring to Tommasi's "Pile Electrique," p. 364. The suggestion that the necessity of freshly electro-plating the copper electrode, every time it is used, might be avoided by amalgamating the copper, would be a very disappointing one to put into practice; for amalgamated zinc and amalgamated copper give a much smaller E. M. F. than the normal one of the Daniell cell. Moreover, it is quite as important that the zinc should be as free from oxide as the copper.

Considering these facts, and the extreme difficulty of preventing admixture of the two sulphates, whoever has had the use of a good Clark cell will never be willing to employ the Daniell except in case of necessity. The high temperature coefficient of the Clark cell can hardly be urged against it now, since its value has been reduced to half its former one. The editorial remarks in THE ELECTRICAL ENGINEER on existing standards of E. M. F. appear to throw some discredit on them. As an indication of their permanence and reliability I shall take the liberty of quoting some figures which I have obtained.

I have a Clark standard which I made four years ago after Lord Rayleigh's directions. It was one of the very first cells I ever made. Two months ago I made two more, again in accordance with Lord Rayleigh's directions. Of course the materials were from entirely different lots. In addition, I have a Rayleigh cell, four years old, put up in a wide-mouthed bottle. This has been used promiscuously by perhaps one hundred students in the laboratory. A comparison of the four cells on April 1 gave the following relative values of the E. M. F., the numbers given being the ohms required to effect a balance by the Rayleigh method of comparison:

Old Rayleigh Cell - -	at 20°.5C.	9,118
First new Rayleigh Cell - -	" "	9,118
Second new " " -	" "	9,116
Cell in bottle - - - -	" "	9,117

One week later at 12°.7C. the first three gave 9,179, 9,176, 9,176, respectively. The other was not compared.

I have ten cells, of my own special make, in a rack by themselves that never, I think, show an extreme difference among them of more than five parts in ten thousand. I consider Clark standard cells quite indispensable in an electrical laboratory.

SIMS-EDISON TORPEDO.

THE first exhibition in Europe of the Sims-Edison torpedo lately took place at Harve, on the coast of France, and with success. Representatives of the English, French, Spanish, Russian, Italian, Turkish, and Japanese governments, and the principal daily papers, watched a semi-public trial at the same place, as guests of the Société des Forges et Chantiers. Mr. Sims was in charge of the switchboard, and directed the operations of the torpedo, which made a long circuit and returned towards shore. The speed and complete submission to the will of the operator were clearly demonstrated.

DEMING'S AUTOMATIC SAFETY ELECTRIC SYSTEM FOR RAILWAYS.

BY

Edward P. Thompson

In safety systems now in use accidents still continue, not because the systems get out of order, but because some one is careless or forgetful, or because there is some "good reason" why the signal was neither heard, nor seen, nor set. Man cannot be depended upon as well as something which is automatic in its action. Thus, in case of a train going at the rate of 60 miles per hour, 20 seconds of inattention or absent-mindedness may cause a frightful accident.

Mr. Edward Deming, of this city, provides a system such that if two trains are approaching each other at any speed, and without an engineer or other person on board, both trains will stop when within a predetermined, or dangerous, distance of each other. The same system operates to stop a train approaching a stationary train from either direction, or an open bridge or switch, or grade crossing where two trains are about to collide at the crossing.

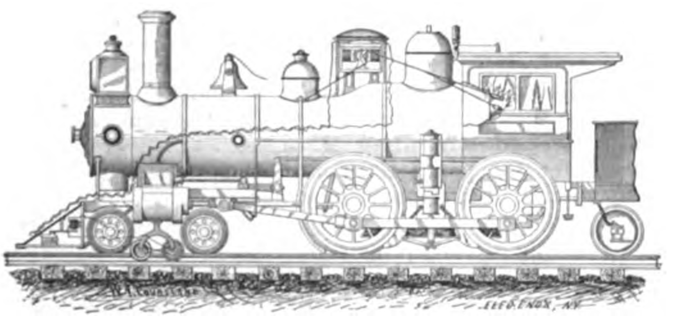


Fig. 1.

The system is operative, therefore, if a fog exists, or the engineer is thinking about other matters, or is color blind, or the curves are short and numerous. It is controlled by apparatus located upon the two trains; or upon one train on the one hand, and on the switch, bridge or crossing, on the other.

The system is illustrated in the accompanying engravings, Fig. 1 showing it as applied to a locomotive, Fig. 2 to a draw-bridge, and Fig. 3 to a crossing. It consists in equipping the locomotive, for instance, with a small electric motor, set on top of the boiler between the steam dome and sand box, and having levers connecting with the handles of the brake, throttle and sand box. The motor is in circuit with a local battery conveniently situated in the cow-catcher, and introduced in circuit with the motor by the magnet also seen in the cow-catcher. This magnet is in an open circuit with a generator on the last car of a second train, and with generators at the bridge, switch or crossing. At predetermined distances these generators will become closed through the magnet, on account of the provision of double sectional conductors extending along the track. One of these conductors is in permanent connection with the magnet, while the other joins the generator in the last car of a second train, or at a switch, etc. The remaining terminals of the magnet and generators have permanent connections with the rails which serve as ground returns.

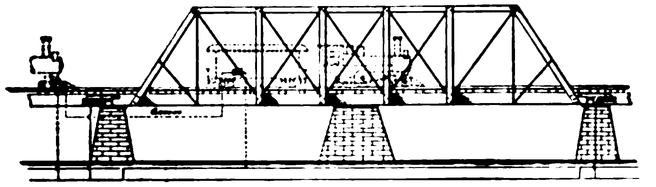


Fig. 2.

From what has just been described, it is evident that upon the approach of two locomotives within the predetermined distance, the circuit will be closed and the motor on the locomotive at once be started to close the throttle and apply the brakes automatically. The system thus makes the engineer independent of all signals and increases the safety of travel accordingly.

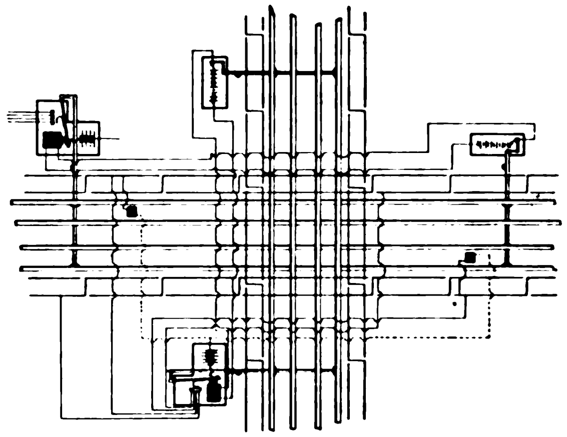


Fig. 3.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—I.

BY

Chas. Steinmetz.

Introduction.

Since the alternate current system is coming more and more into general use for electric light and power distribution, the alternate current transformer, or converter, as the most essential part of this system, has gained an importance, which but a few years ago nobody would have expected, to judge from its experimental predecessor, the induction coil.

But, since at present all mathematical and analytical theories, especially if they have to start from the solution of differential equations, are still of very little value for the "practical engineer," who is not yet generally expected to master the powerful weapons of mathematics, it may be considered of some interest, if in the following I try to give an explanation of the fundamental phenomena met with in transformers, so far as they are of importance for the designing and working of alternate-current transformers, and of some phenomena, which, although found less often in transformers, are generally noticed by their destructive effects, such as oscillating discharge, some effects of static capacity, etc. I propose to show this in a way which presupposes no higher mathematical knowledge than the acquaintance with the sine-function, and perhaps the elements of infinitesimal calculus. The application of the diagrammatical method will be found equally adapted for the treatment of other alternate current apparatus, although the limited space available does not allow me to enter deeper into the consideration of apparatus other than transformers.

Indeed, I do not at all claim to be the first to use graphical representations of alternate current waves, but many applications of similar methods can be found in the publications of Kapp and others, and especially in Blakesley's.

But so far as I know they all represent the instantaneous values of the current, the E. M. F., etc., by the projections of a line $\overline{OX}$ upon the centre line $\overline{OA}$, the line $\overline{OX}$

representing the maximum value of the current, etc., and giving by one revolution around the centre O the time of one complete period. This representation has the disadvantage of giving the instantaneous values of the electric or magnetic quantities not on the variable radius which represents the time, but all on the line OA, and therefore does not show so well the relative magnitude of different quantities; it fails especially to give a characteristic curve which allows us to survey the whole change of the periodic function at once; besides, it can be used conveniently only for true sine-waves. We shall in fact restrict ourselves generally to the consideration of true sine-waves, and also show the action of other shapes of electric waves only occasionally.

But in reality the currents of our modern alternators differ from true sine-waves only slightly, and self-induction and mutual induction have the tendency to make the shape of the current wave still more sinusoidal. Therefore, in supposing a true sine-form we will approximate the real actions in alternate current apparatus at least very nearly, and may be allowed to treat the differences caused by a differing shape of the wave only as correctional terms of secondary order.

Of fundamental importance is the law, that several sine-waves always combine into sine-waves again, are always induced by sine-waves, and induce sine-waves; indeed, waves with a shifted phase.

Therefore:

"*If the primary* E. M. F. *of a transformer follows the sine-law, all the* E. M. F'S. *currents and* M. M. F'S.[1] *must follow the sine-law also.*"

The only phenomenon, which, when heavy self-induction is present, is apt to change the sinusoidal shape of the current wave—the E. M. F. being a true sine-wave—is *hysteresis.*

But here experimental tests show, that in almost all cases, the influence of hysteresis can be replaced by a current of the same phase as the induced E. M. F., which current, by its effect, represents the energy expended in the reversals of magnetism. Then hysteresis is also represented by a sine-wave.

As an example for showing the application of the *polar-diagram of alternate currents*, let us consider a transformer, which is intended in its secondary circuit to give an E. M. F. of 70.7 volts, effective.

Then the maximum E. M. F. of the secondary circuit is:

$$E_1 = 70.7 \times \sqrt{2} = 100 \text{ volts.}^2$$

Let the number of complete periods per second:

$N = 133$ (ordinary incandescent-light dynamo frequency), so that, $T = .0075$ second is the time of one complete period.

From this we get the maximum intensity of the "*magnetic current*," necessary to induce the maximum E. M. F. of 100 volts.

For, let the number of primary turns: $n = 80$;

" " " secondary " : $n_1 = 60$.

Then the maximum E. M. F. induced in the secondary by the magnetism M is:

$$E_1 = 2\,\pi\,N\,n_1\,M \text{ (C. G. S.) units, or:}$$

$$E_1 = 2\,\pi\,N\,n_1\,M \times 10^{-8} \text{ volts.}^1$$

This being equal to 100 volts, we derive:

$$M = \frac{E_1 \times 10^8}{2\,\pi\,N\,n_1} = \frac{100 \times 10^8}{2\,\pi \times 133 \times 60} = 200{,}000 \text{ lines of}$$

magnetic force.

We have to choose now the *maximum magnetization, or maximum magnetic field intensity, H,* at which we want to work the transformer.

If we use a high field intensity, for instance $H = 40{,}000$ or 50,000 lines of magnetic force per square inch, we need only a small cross section of iron. Thence the length of the convolutions of the copper wire become shorter, and thereby the *loss of energy in the copper* smaller.

This not only affords a saving of material and of energy in the copper, but also a better compounding of the transformer, so far as the electric part of it is concerned, because the drop of potential for full load decreases with the decreasing internal resistance.

On the other hand, with the increasing field intensity the *loss of energy in the iron*, due to *hysteresis and eddy currents*, increase faster than the field intensity, so that, if we double the field intensity, although we are able then to halve the iron cross section, nevertheless we shall find the whole amount of the iron loss essentially increased; because for twice the magnetization the iron loss per cubic inch is more than doubled, being about 3½ times as high, and therefore the whole expenditure of energy in the iron about 1¾ times its former value; so that this increased iron loss might more than counterbalance the gain by the saving of energy in the copper, and the greater "magnetizing current" (termed "resulting M. M. F." in the following) needed for the production of the magnetism makes the compounding of the converter still worse.

The *loss of energy due to hysteresis* proper in the iron, besides being directly proportional to the number of periods used, seems to be nearly proportional to the 1.6th power of the magnetization, as I have already calculated[2] from observations made by Ewing, and as my own tests made subsequently seem to prove:

$$H = A\,B^{1.6} \times N.$$

The *loss of energy due to eddy-currents* in the iron must be very nearly proportional to the square of the magnetization, and proportional to the *square* of the number of periods used:

$$\Lambda = \varepsilon\,B^2 \times N^2.$$

Hence, the loss by eddy-currents will be more perceptible than the hysteretic loss for higher magnetization and greater number of periods; but very small for low magnetization and small number of periods. Then the iron loss will consist mainly of static hysteresis.[3]

Eddy-currents can hardly be avoided. I do not think that they circulate as much in the thin iron laminæ themselves, but that they find an easy circuit from lamina to lamina through the whole length of the iron. At least in all the (commercial) transformers, and in a number of other laminated electromagnets, which I had occasion to test for it, I found electric connection through the whole pile of iron laminæ, such a good connection, that I could not even determine its resistance, without going into more complicated measurements. Therefore the losses in the iron must be expected to increase with a higher power than 1.6, and a lower power than the square of the magnetization.

---

1. In the same way as we use "E. M. F.," I shall in the following abreviate *magnetomotive force* (measured by ampere-turns) to "M. M. F."

2. If: E_1 = the maximum E. M. F., we have:

$$e_1 = E_1 \sin \frac{2\,\pi}{T}\,t = E_1 \sin 2\,\pi\,N\,t,$$

the instantaneous value of the E. M. F. at the time, t;
where T = the time of one complete period, or:
N = the number of complete periods per second,

$$e_1^2 = E_1^2 \sin^2 2\,\pi\,N\,t.$$

The square thereof,

$$N\int_0^T E_1^2 \sin^2 2\,\pi\,N\,t\,d\,t = \frac{N\,E_1^2}{2}\int_0^T \{1 - \cos 4\,\pi\,N\,t\}\,d\,t = \frac{N\,T\,E_1^2}{2} = \frac{E_1^2}{2},$$

the mean square of the E. M. F., and:

$$\frac{E_1}{\sqrt{2}},$$

the "*square root of the mean square*" or the "*effective*" E. M. F.

1. The "magnetic current" at the time t is:

$$m = M \sin 2\,\pi\,N\,t; \text{ where, } M = \text{maximum magnetism.}$$

Therefore the E. M. F. induced in the secondary circuit:

$$e_1 = -n_1\,\frac{d\,m}{d\,t} \times 10^{-8} = -n_1\,M\,2\,\pi\,N \cos 2\,\pi\,N\,t \times 10^{-8} \text{ volts,}$$

hence a maximum, E_1 for: $\cos 2\,\pi\,N\,t = -1$; $t = \frac{1}{2\,N} = \frac{T}{2}$, and

$$E_1 = 2\,\pi\,N\,n_1\,M \times 10^{-8} \text{ volts.}$$

2. See "Note on Hysteresis," THE ELECTRICAL ENGINEER, Dec. 17, 1890.

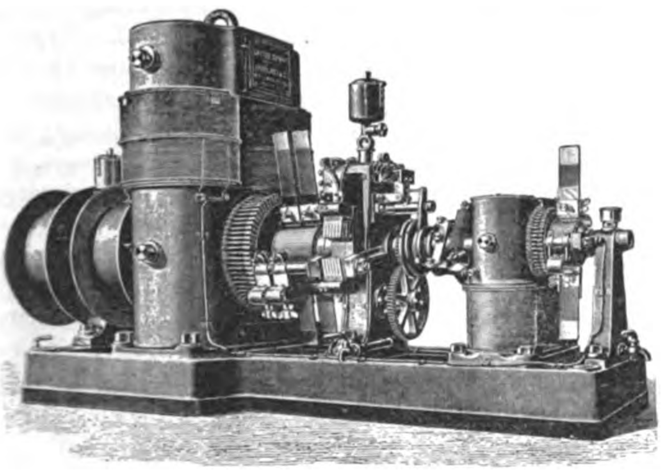
3. This gives a very convenient way to separate the true hysteretic loss from the loss due to eddy currents, by determining the loss in the iron for different frequencies, or for different magnetic intensities.

For well-insulated magnets, and the usual number of alternations, I found the assumption of an increase of the iron loss proportional to the 1.7th power of the magnetization (field intensity) generally pretty near the real facts; near enough at least to be used in designing new work. In three more complete sets of tests I found the iron loss fairly well proportional to the 1.68th, 1.70th and 1.925th power of the field intensity, for 100 complete periods per second. In the third case, no paper insulation was used between the iron laminæ.

HOLMES' TRAIN LIGHTING DYNAMO.[1]

Many attempts have been made to light trains electrically, the chief difficulty being in the variation of speed of driving the dynamos. Separate engines have been used, but have been found unsatisfactory. We illustrate a solution of the problem, due to the ingenuity of Mr. J. Holmes, of Newcastle. The inventor explains his dynamo as follows:

Practically the E. M. F. of an ordinary separately excited dynamo varies directly as the speed, so if the speed be increased, say, from 500 revolutions per minute to 1,000 revolutions per minute, the electromotive force will be doubled. The electromotive force varies directly as the strength of the magnetic field, so that, if the strength of field of a separately excited dynamo be reduced in the same proportion as the speed at which its armature revolves be increased, the electromotive force of the armature will remain practically constant.



Holmes' Train Lighting Dynamo.

To produce this result two dynamos are arranged having their armatures upon the same shaft, so as to revolve together, but influenced by separate magnetic fields. One is the main generating machine, the other is for regulating the strength of its magnetic field. The magnets of the machines are separately excited from an external source, such as a set of accumulators, and the magnets of the generating armature are provided with two distinct exciting circuits. One circuit is an ordinary high resistance shunt circuit, and the other is of less resistance, and is coupled up to the source of current so as to have the small regulating armature in series with it. The regulating armature is so coupled up that its electromotive force opposes the electromotive force of the regulating armature and external source of supply. The high resistance shunt circuit is so proportioned that, at the highest speed at which it is intended to run the generating armature, it, without the aid of the regulating circuit, will give a magnetic field of an intensity proper for the required E. M. F. in the generating armature. When thus driven, the second exciting circuit ought to have no current passing through it, and this is secured by making the E. M. F. of the regulating armature at its highest speed equal, and opposite, to the external source of E. M. F. produced in the second coil of the generating machine. If, however, the speed falls, the E. M. F. of the regulating armature is reduced in the same proportion, and is no longer equal to the external E. M. F., and a current will flow through the second exciting circuit of the magnets of the generating dynamo, thus increasing the intensity of the magnetic field to make up for reduction of speed, maintaining a practically uniform E. M. F.

The armature is driven by belting from the axle of the guard's van, and a set of accumulators excite the field magnets. A centrifugal governor automatically switches the storage batteries in or out. The brushes which collect the current from the two armatures are made of wire gauze, and are placed radially, the "lead" being automatically altered to suit the direction of rotation. The connections to the armature are changed at the same time.

This dynamo is used by the Midland Railway Company for their express trains, and has also been applied to French, German, and Russian railways.

CATAPHORIC MEDICATION.

At the recent ordinary meeting of the Society of Arts, says our London correspondent, Mr. W. Preece, F. R. S., presiding, Mr. H. Newman Lawrence read a paper on "Electricity in Relation to the Human Body," the joint production of himself and Mr. Arthur Harries, M. D. After glancing at the increased importance of the subject at the present day, when electrical apparatus is so largely employed, the authors observed that it possessed little or nothing of a history, and they proposed to deal with it mainly in the light of their own experiments and observations. It naturally divided itself into two parts, the one, possible dangers to the body, and the other, possible advantages.

The advantages of electricity to the human system far outweighed its dangers, and these were the subject of the second portion of the paper. It noticed the fact that atmospheric electricity is apparently the cause of the transformation and retransformation of oxygen into ozone, and ozone into oxygen passing through a cycle of changes, commencing with atmospheric electricity and ending with electrical currents within the body. The uses of electricity in disease were numerous and valuable, and they were steadily on the increase. After taking note of some of these, it entered into explanations of the new and important branch of the subject known as "Cataphoric Medication," or the process of passing drugs in solution by means of the cataphoric power of electric currents. Little or nothing was actually known on this subject when the authors began a course of experiments upon it in the Autumn of 1889, and the results of these had been so promising that they proceeded to use it as a method of treatment in actual disease. A demonstration of the method was given in the course of the lecture, but this was preceded by a description in outline of the initial experiments, which were described by Dr. Harries with aid of the blackboard. In the first, two glass vessels were taken. The one was nearly filled with dilute sulphuric acid, the other with a solution of barium chloride. The two vessels were then connected by a piece of lamp wick soaked in a solution of salt, which dipped into the contents of each. After waiting twenty-four hours there was no trace of the chemical action, which might have been expected to ensue in consequence of the connection of the two by the lampwick, but on two electrodes being inserted in the fluids, connected with a battery, and a current of 100 milliamperes being sent through the whole, a precipitation of barium chloride was seen after the lapse of half an hour. The second experiment was a slight advance on the first. A porous septum divided the two solutions, and which were of iodine and starch, respectively, and a small quantity of iodide of starch was formed in the same way. In the cataphoric power of electrical currents the same principle was in operation, the only change being that in place of a porous septum the skin was used, and it could be shown in the trial about to be made of the method in which a solution of cocaine, which was an anaesthetic, would be passed through the skin, that the patient was entirely free from pain during the process. The experiment was then performed, and the operator then inserted a platinum needle, connected by a wire with a handle attached to a galvanic battery, one-sixteenth of an inch below the surface. The patient remained perfectly calm under the process, and the thoroughness of the action was seen in the fact that one or two hairs had been loosened, and were readily removed, the needle having passed into the follicle at the base, in each trial. In answer to numerous questions, Dr. Harries explained that cocaine alone would have produced only a small effect, and that which was seen was really due to the cocaine and the electricity jointly.

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[1] *Industries.*

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Honor those who seek knowledge for her own sake, and remember that they are the great heroes of the world, who work in faith, and leave the result with God.—Josiah Parsons Cooke.

THE RAPID TRANSIT REPORT.

IT is impossible to be other than very well pleased with the report of the New York Rapid Transit Commission, which is printed in our columns this week. As will be seen, this report, in dealing with the questions of rapid transit for the West Side of this rapidly growing city, proposes an underground four-track road, with electricity as a motive power, two of the tracks being devoted to express service and two to way trains. We are glad to see that the report has been well and warmly received, the only adverse criticism coming from such interested quarters as the *Sun*, which makes itself the mouthpiece of the Elevated Railroad Company.

The engineers of the Commission are to proceed at once to the perfection of plans for the road, while the Commission itself deals next with the waiting problems of the East Side. The estimate of outlay for the road to run from South Ferry to the City Line on the west is about $40,000,000, and the Commission have assurances from capitalists that the amount can be easily raised. There should be no reasonable doubt as to the success of the road as a paying investment. The route lies through a thickly populated district, whose needs are well indicated by the fact that the traffic of the elevated system increased by nearly 75,000,000 passengers between 1886 and 1890, and that in the meanwhile the Broadway horse car service came into operation to carry many millions annually, and to pay handsome dividends. Moreover, from the fact that the road will place Harlem within 12 minutes of the City Hall, it will develop a new and enormous traffic of its own, and preempt the whole of the vast semi-suburban region between Eighth avenue and the Hudson and Grant's Tomb and Yonkers, which hitherto has not enjoyed a service distinctively its own, and has not the remotest idea of the real meaning of rapid transit. Electrical engineers should congratulate themselves that to them the larger portion of the population of New York is now looking for swift and safe travel between home and work.

THE DESIGNING OF ALTERNATING CURRENT APPARATUS.

ALTERNATING current apparatus of various types has now been in practical operation a sufficient length of time to afford an abundance of data upon which to base tolerably accurate calculations, and as time goes on constructors will be facilitated in their work by the successful practice of improved methods. But as it is the living present which most concerns the electrical engineer, he naturally looks about for the methods nearest at hand, and in the most convenient form. The graphic method has proved of great assistance in solving mechanical engineering problems, and in the design of electrical machinery the advantages possessed by this method were also early recognized. To promote the study of alternating current apparatus by the graphical method, we begin, in this issue, a valuable series of articles by Mr. Charles Steinmetz, in which, basing his determinations upon the results of actual experience, he shows how the data at hand can be employed in the designing of the most efficient apparatus. Although this method has been employed before, its use has been limited to but a comparatively few cases. Mr. Steinmetz's articles, however, will treat the problem in a way which will be generally applicable, while at the same time giving examples showing the method of applying this system of designing to particular cases.

WORLD'S FAIR NEWS.

IT is now definitely understood that the recently proposed solution to prevent an extended division of the electrical exhibit, will be adopted. By this plan, which, under the conditions, is excellent, and appears to be the best practicable method, all the generating plant will be placed in a portion of the Machinery Annex, occupying as much space there as required, and the necessary electrical energy will be furnished from there to the Electricity Building, and to all parts of the Exposition. The placing of all the various electrical generators, and the power machinery operating them, together in the Machinery Annex, will form a vast and most interesting exhibit of the various systems of producing electrical energy, and will be, to all intents and purposes, part of the electrical exhibit forming an annex to the Electricity Building.

The Electrical Department and the Construction Department, of the World's Columbian Exposition, are working together in perfect harmony, and all differences of opinion have now been happily settled by the aforesaid excellent solution of the main points of contention, and the good work will now go on rapidly and vigorously to completion

The employment of electrical energy for every conceivable purpose in every part of the Exposition, will be carried out in the most extensive manner, and it will be found on all sides furnishing lighting, heating, power and traction; making an unparalleled display and demonstration of the marvelous adaptability of electricity.

Prof. Barrett, Chief of the Electrical Department, is working strenuously to bring about a magnificent exhibit and satisfy the electrical people in every particular, and Mr. Frederick Sargent, the electrical engineer of the Construction Department, is pushing matters along with the utmost dispatch, to carry out the requirements of Prof. Barrett.

STANDARD CELLS.

It is with pleasure that we accord space in this week's issue to a communication on standard cells by Prof. H. S. Carhart. This communication is called forth evidently by our editorial remarks on the type of standard cell recently described by Mr. Carl Hering before the Franklin Institute and reproduced in our pages. We are in perfect accord with Prof. Carhart's advocacy of the Clark cell as prepared under the directions given by Rayleigh, and believe that its constancy is as nearly perfect as can be obtained in a standard of this type. But in our remarks above referred to we drew attention to the fact that what was wanted was a standard "*simple in construction* and permanent in its indications under all conditions." Granted that the Clark cell is sufficiently permanent in its indications for all practical purposes, we believe that the difficulties of procuring the pure materials necessary for its construction will always be a bar to its general or universal employment, and hence it does not fulfill the dual conditions above quoted. Those conditions must be the attribute of every "standard" in order to secure its universal utilization. Meantime, there will, of course, be more and more use for the standard cell for many years to come. The thing to replace it has not yet made an appearance.

ARMATURE REACTION IN CONSTANT CURRENT DYNAMOS.

The study of the dynamo electric machine has in the past been largely concentrated on the constant potential type of machine, with the result that there is comparatively little which the student or constructor finds available when he essays the designing of constant current machines. The small magnetic strength of the armature, which forms the characteristic of constant potential machines, makes the question of armature reaction of lesser importance, but the enhanced magnetic value of the constant current armature, as compared with that of the field magnet, makes the reaction of the constant current armature enter as an important factor in the operation of the machine.

In discussing this feature in a recent paper read before the Chicago Electric Club, Prof. H. S. Carhart, after referring to the nature of the characteristic curve required in a properly acting constant current machine, held that so far as the direct influence on the field is concerned, the nature of the armature reaction is referable to two quite distinct factors. The currents circulating round the armature reduce the magnetic flux both by increasing the magnetic resistance or equivalent length of the magnetic surface and by generating a counter magneto-motive force. The former is affected in just that portion of the circuit where the resulting change is the greatest, that is, in the air interspace adjacent to the polar faces. The other factor appears to play a much more important part in regulation by motion of the brushes than the deformation of the field at the polar tips; for by means of it the brushes may be kept nearly sparkless from full load to short circuit. That the magneto-motive force, having its origin in the ampere-turns on the armature, is inverse and not direct is evident from the fact that when the brushes were rocked forward the poles induced in the armature by the field are always of opposite sign to those produced by the armature currents. Hence these currents circulate in such a direction as to demagnetize the field.

To verify the correctness of his assumption, Prof. Carhart studied the reactions taking place in the armature by means of a third brush and measuring the potential differences between the main brushes and third brush placed at various points around the commutator. On the machine he experimented with, one of the first of the Gramme type constructed in this country, Prof. Carhart finds that if the total electromotive force of the generator remain constant, then, as with a battery, the increased current means increased loss of potential in the armature, and therefore a smaller difference of potential at the brushes; and if smaller at the main brushes it will be smaller between the point of derivation of the supplementary circuit.

His experiments also showed that, on account of the reaction of the armature, the region of the commutator on either side of a brush, or the armature coils in these positions, is a relatively weak field, the angular distance through which the potential rises to a maximum being nearly double that required to bring it down again to the level of the main brush.

The change of voltage in the third brush circuit, whenever the main current varies from its normal value, suggests to Prof. Carhart the practicability of utilizing this relation for the purpose of securing automatic regulation of the current, and he has tried this method with satisfactory success. The third brush circuit contained an electro magnet as a responsive device, and this served to bring into action either an electro magnetic motor or mechanical motor mechanism for rotating the brush holder.

Incandescent Lamp Economy.

Quite recently the marked decrease in the price of incandescent lamps served again to bring out prominently the laws which govern the highest economy attainable in this class of work; and in a recent issue we printed an excellent disquisition on the subject by Mr. H. Ward Leonard, who showed conclusively that with the lowering in price, lamps could be burned at higher efficiency, and hence with shorter life, and still prove more economical than the longer lived lamps. In this issue Mr. W. D. Weaver brings up to date the results of calculations made on this point a number of years ago, and which show that his early analysis was correct. His figures agree very well with those of Mr. Leonard and ought to be studied by every central station manager.

INCANDESCENT LAMP ECONOMY.

BY

W. W. Weaver

ASSISTANT ENGINEER, UNITED STATES NAVY.

SOME years ago the writer published,[1] under the above caption, the results of a mathematical investigation into the commercial efficiency of incandescent lamps (probably the first that appeared in print), and as the subject is now one of increasing importance, a *résumé* may be of interest, particularly as recent data permit more accurate deductions to be made.

An investigation of numerous lamp tests showed that the curves of the variation of candle power with the energy furnished the lamp were of the form, $C E = k_1 x^n$, where C = current, E = E. M. F., and x = c. p., and the value of the constant n was found to be 2.85, which the data of subsequent tests have verified. The value of n from all tests varied little, while in the formula $C = k x^n$ the variation was considerable.

The result of elaborate experiments to determine the variation of the life of a lamp with the c. p. at which it is used was communicated to the writer as being expressed by the equation $l = \frac{k_2}{x^m}$ which relation held true "for even the widest ranges of c. p.," the value of m being given as 3.65.

From these two, and other relations given below, the following formulæ were deduced, the notation being as follows:

a = entire cost of one h. p. per hour delivered at the lamp, depreciation of plant and interest on capital being taken into account.
b = cost of lamp;
x = c. p. of lamp;
y = entire hourly cost of unit light (one c. p.);
l = life of lamp;
C = current;
E = E. M. F.;
P = normal c. p. of a lamp;
W = watts per lamp at normal c. p.;
L = life of lamp at normal c. p.

Then,

$$\frac{b}{l\,x} = \text{hourly } lamp \text{ cost of one c. p.}$$

$$\frac{C\,E}{746} \times a \times \frac{1}{x} = \text{hourly } energy \text{ cost of the same.}$$

$$\therefore\ y = \frac{b}{l\,x} + \frac{a\,C\,E}{746\ x} \quad - \quad - \quad - \quad - \qquad (1.)$$

Substituting for $C\,E$ and l their values from the equations $C\,E = k_1 x^n$ and $l = \frac{k_2}{k^m}$ and reducing,

$$y = \frac{b}{k_2} x^{m-1} + \frac{a\ k_1}{746}\ x^{\frac{1-n}{n}} \quad - \quad - \quad - \qquad (2.)$$

Differentiating and placing $\frac{d\,y}{d\,x} = 0$, we have for the value of x at which y is a minimum:

$$x = \sqrt[\frac{m\,n-1}{n}]{\frac{a\ k_1\ k_2\ (n-1)}{746\ b\ n\ (m-1)}} \quad - \quad - \quad - \qquad (3.)$$

Substituting for k_1 and k_2 their values $\frac{W}{P^{\frac{1}{n}}}$ and $L\,P^m$ respectively, we have the final general expression,

$$x = P \times \sqrt[\frac{m\,n-1}{n}]{\frac{a\ W\ L\ (n-1)}{746\ b\ n\ (m-1)}} \quad - \qquad (4.)$$

Taking $16 = P$ as the normal c. p., and m and n 3.65 and 2.85, respectively, we have finally,

$$x = 1.4 \sqrt[3.3]{\frac{a\,W\,L}{b}},\ x = 1.4 \sqrt[3.3]{\frac{a\ W\ L}{b}}, \qquad (5.)$$

From equation (5.) Tables I. and II. have been calculated. In the first table it is assumed that the cost of the lamp is 40 cents, and in the second table, 60 cents. The figures in the first column are the watts with which the unit light is produced at the normal c. p. (16); the cost of the hourly h. p. is given in the second column in cents, and is the entire cost of an electrical h. p. delivered at the lamp, interest on, and depreciation of, plant being included; the life of the lamp at the normal c. p. is given at the head, and the remaining figures are the respective c. p.'s at which the cost of the unit light, under the conditions given, is a minimum.

CANDLE POWER AT WHICH COST OF UNIT LIGHT IS A MINIMUM.

TABLE I.

Cost of lamp = 40 (b).

Watts per c. p. $\left(\frac{W}{16}\right)$	Cost of hourly h. p. (a).	Life of lamp (L). Hours.		
		600	800	1,000
	1	10.4	11.4	12.2
3.1	3	14.6	15.9	17.0
	5	17.	18.5	19.9
	1	11.	12.	12.8
3.7	3	15.3	16.7	17.9
	5	17.9	19 6	20.9
	1	11.3	12.4	13.2
4.1	3	15.9	17.3	18.5
	5	18.5	20.2	21.6

TABLE II.

Cost of lamp = 60 (b).

Watts per c. p. $\left(\frac{W}{16}\right)$	Cost of hourly h. p. (a).	Life of lamp (L). Hours.		
		600	800	1,000
	1	9.2	10.	10.7
3.1	3	12.8	14.	15.0
	5	15.	16.4	17 5
	1	9.7	10.6	11.3
3.7	3	13.5	14 8	15.8
	5	15.8	17.3	18.5
	1	10.	10.9	11.7
4.1	3	14.	15.2	16.3
	5	16.3	17.9	19.1

Tables III. and IV. were calculated by means of equation (2.) and Tables I. and II., and show the relative minimum cost of the unit light under the conditions given; or, in other words, if the filaments of the lamps represented by the figures in Tables I. and II. were burned at the incandescence necessary to produce the c. p.'s as deduced, but lengthened or shortened so as to all give a uniform quantity of light, 16 c. p., say, the figures in Tables III. and IV. show the relative minimum cost of the light.

RELATIVE VALUES OF MINIMUM COST OF UNIT LIGHT.

TABLE III.

Cost of lamp = 40 (b).

Watts per c. p. $\left(\frac{W}{16}\right)$	Cost of hourly h. p. (a).	Life of lamp (L). Hours.		
		600	800	1,000
	1	11.0	10.4	1.00
3.1	3	25.7	25.2	24.1
	5	40.3	38.0	36.5
	1	12.7	12.0	11.6
3.7	3	30 6	29.0	27.8
	5	46.4	43.8	42.0
	1	13.8	13.0	12.5
4.1	3	33.4	31.5	30.2
	5	50 4	47.6	45.6

TABLE IV.

Cost of lamp = 60 (b).

Watts per c. p. $\left(\frac{W}{16}\right)$	Cost of hourly h. p. (a).	Life of lamp (L). Hours.		
		600	800	1,000
	1	11.9	11.3	10.8
3.1	3	28.9	27.3	26.1
	5	43.6	41.2	39.5
	1	13.7	13.0	12.4
3.7	3	33.3	31.5	30.0
	5	50.2	47.4	45.4
	1	14.9	14.1	13.5
4.1	3	36.2	34.2	32.7
	5	54.6	51.5	49.4

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[1] THE ELECTRICAL ENGINEER, April and September, 1885.

These latter tables show several interesting facts. For example, accepting the constants given, when lamps are used under the necessary conditions to give the minimum cost, the 40 cent lamp with a life of 600 hours is as efficient as the 60 cent lamp with a life of 1,000 hours, while, with an equal life, the 4.1 watt 40 cent lamp is as efficient as the 3.7 watt 60 cent lamp. If the same constant could be accepted, deductions similar to those made for Tables I. and II. would fix the length and incandescence, approximately, that should be given to a filament.

Unfortunately, however, the value of the constant *m*, as given, was determined for only one kind of a lamp, so that its value can only be provisionally accepted. On the other hand, equation 4 remains true and should prove of considerable practical value when this constant has been determined to some degree of exactness.

THE FUTURE OF THE ALUMINUM PROBLEM FROM THE CHEMICAL STANDPOINT.[1]

BY DR. WM. H. WAHL.

Dr. Wahl began with an interesting discussion of the chemical reactions in the metallurgical method of reducing aluminum, with special reference to the processes of Deville-Castner, and Netto. Speaking, then, of the electrolytic method, he continued:

On the basis of these facts and inferences let me present you with an interesting comparison. I will employ to this end the deadly parallel columns, with full knowledge of the risk of handling so dangerous a weapon.

Capt. Alfred E. Hunt, in a lecture recently delivered before the Boston Society of Arts, gave the following estimate of the probable cost of manufacturing aluminum by the electrolytic method practiced by the Pittsburgh Reduction Company, of which he is the head. This estimate is based on the assumption that the manufacture shall be conducted on a scale of much greater magnitude than at present and with the cheapest source of power, namely, water power. *Apropos* to this estimate of Capt. Hunt, I wish to remark that it has afforded me a most interesting subject for study, and I desire here to declare my conviction that it is in no single item exaggerated on the side of economy. Respecting one of the figures named—that of the cost of water power—I entertained at first some doubts as to its accuracy, and to satisfy myself on the point I presented the inquiry to my friend, Prof. Coleman Sellers, an engineer of wide experience and at present one of the Board of Consulting Engineers to the Cataract Construction Co., which is engaged in the important work of utilizing on a grand scale the water power of Niagara Falls. I will take the liberty of quoting to you from a letter which I received from him some data covering the subject of my question:

"Almost all the existing examples of water power are dependent upon accumulation of water in reservoirs created by erecting dams across existing rivers and so accumulating water and distributing it by canal to the water wheels, as at Holyoke, Lawrence and our own Schuylkill river. The water power, for instance, of the Schuylkill, and sold by the Schuylkill Navigation Co., was quite limited in its amount and is already exhausted, and it may be assumed to be somewhere in the neighborhood of $30 or $35 per horse-power per annum, for day use only. These water powers are generally sold either by day use or by 24 hour use, and for the purpose of metallurgical reductions it would probably be required on the 24 hour basis.

"The difficulty about getting at the cost of these water powers is the uncertainty of the continuance of the dams that are built to retain the water. These are liable to decay and deterioration and sudden freshets often destroy them entirely, involving heavy costs that are not known until the event occurs. The exceptional case of Niagara presents an absolutely unfailing water power that does not vary the year round. The difficulty in the way of its use, however, consists in the extreme width of the breast of the dam and the necessity for carrying the water through a long surface canal to the lower chasm where it is to be used, or the digging of the tunnel as a tail-race to carry away the water that has been used from the wheels or other motors.

"A canal was built about 40 years ago which is still in use, that carries about 6,000 horse power to the lower river, but this amount of power has already been more than exhausted by users who availed themselves of it, and its further extension by that method would be very costly. The present scheme of utilizing Niagara Falls by the company in which I am interested, is by means of a tail-race tunnel under the town of Niagara, and the preliminary work now being done, when completed, in about a year, will throw into the market about 120,000 horse power that may be said to be absolutely permanent and endurable and capable of being worked for 24 hours in the day. It is premature to say what this power will bring in the market, but it is the only example I know of where water power can be counted on as absolutely staple and not liable to any disturbance or delay, and where the price will be comparatively low. I should think that you might safely say that it presents the possibility of power being obtained at less than half of what it would cost in any other known case, taking into consideration all contingencies. Small amounts of power may be obtained from streams of water of a reasonable degree of stability and far away from existing markets, as low probably as $4 or $5 per horse power per annum, but this is subject to the risk before mentioned.

"It is not alone the mere cost of water power that must be considered, but in a case like this it is the continuance or permanency of the power that will give it its value and that power will be the most valuable that is liable to the least fluctuations either in quantity or cost. I do not think, however, that it will be safe for you to predicate the value of metal produced upon anything short of about $15 per horse power per annum, for 24 hour power, and that in very large quantities, while perhaps $20 per horse power per annum would cover all contingencies."

Taking the estimate of $20 per horse power per annum as sufficient "to cover all contingencies," we would have as the cost of one horse power per hour 0.238 cent (or, say, about one-fourth of a cent.

This would give for 22 h. p. 5¼ cents, and for 22 electrical horse-power, allowing 10 per cent. for loss in the conversion, 6 cents. Capt. Hunt allows 5 cents for his power, which, considering that the figure named by Prof. Sellers is obviously intended to be liberal, I feel satisfied is a fair one. This item of Capt. Hunt's estimate is the only one respecting which I have at any time entertained any doubts, and I have been so impressed in reading his admirable lecture, with the carefulness and accuracy of his statements, and his evident desire to avoid any suspicion of exaggeration, that I am quite prepared to accept the other figures, which are based on the experience gained in the practical working of company's plant.

Capt. Hunt's estimate of the capabilities of the electrolytic method of producing aluminum on the largest scale is as follows:

BY THE ELECTROLYTIC METHOD.

COST OF PRODUCING ONE POUND OF ALUMINUM.

2 lbs. alumina (containing 52.94 per cent. Al_2) at 3 cents	.06
1 lb. carbon electrodes, at 2 cents	.02
Chemicals, carbon dust and pots	.01
22 H. P. for 1 hour (water power)	.05
Labor and superintendence	.03
General expense, interest and repairs	.03
	$.20

BY THE METALLURGICAL METHOD.

COST OF PRODUCING ONE POUND OF ALUMINUM.

3¼ lbs. Al_2F_6 (containing 32. 7 per cent. Al_2), at 3 cents	.09¾
2½ lbs. sodium, at 3½ cents	.09
Labor, superintendence	.03
General Expenses, Interest and repairs	.03
Total	$.24¾

The fundamental fact that alumina can be reduced to the metallic state by carbon, is established. It is proved beyond peradventure by the operation of the electric furnace of the Cowles Bros., in which heat, developed by the transformation of electric energy upon the passage of the electric current through a fragmental resistance material of carbon and alumina (with copper or other metal present as a solvent), is believed to be the principal agency in effecting the reduction. The same action may probably take place, to some extent, in the operation of the Heroult furnace, and certainly so, if the statement can be verified that the output of this furnace is greater than can be accounted for by simple electrolytic action.

The reduction of alumina by carbon, therefore, may safely be stated to be simply a problem of temperature, and this temperature is probably not far above the fusion point of alumina. This, unfortunately for the practicability of the direct reduction process, lies enormously high, so high, indeed, that it does not admit of instrumental measurement, but can only be approximately estimated as somewhere between 2,000 and 2,600 C.; a point which cannot be reached save by the intervention of electric heating.

There is an alternative, however, that offers a ray of hope to the chemist. There are other methods besides that of fusion for obtaining alumina in the state of a liquid. We have, at least there are very good reasons to believe that we have, solvents for alumina, and if the condition of fluidity is as important a factor as it is believed to be in inducing chemical reactions, we have the possibility open to us of establishing conditions favorable to the reduction of alumina by carbon, at temperatures perhaps far below the fusion point of alumina.

The fluorides of the alkalies and the alkaline earths, we have reason to believe, dissolve alumina freely, and there are other compounds into which alumina enters that may be dissolved in the proper menstrua.

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, May 21, 1891.

Briefly summarized, the case stands thus :

The processes in which electricity is applied, either for the direct reduction of aluminum by electrolysis or as the agency for producing the heat required to effect its reduction by chemical reactions, have outstripped the metallurgical methods in the race for supremacy and have taken a decided lead.

Within the past two years the metallurgical processes as represented by the improved methods of Castner, Netto, Grabau, and others of less renown, have been forced to abandon the field to the electrical methods of Hall, Minet, Cowles and Heroult.

REPORT OF THE NEW YORK RAPID TRANSIT COMMISSION IN FAVOR OF THE UNDERGROUND ELECTRIC ROAD.

THE Rapid Transit Commission has filed the results of its labors in the following :

Resolved, That after a thorough investigation, it is the sense of this board that any additional rapid-transit system for the city of New York should embrace the following essential features :

1. That it should be such as to provide not only for present needs, but also be susceptible by additions, and not by radical changes or alterations, of such expansion as the future growth of the city may require.
2. That it should provide for express trains at high speed for long distances and for way service for intermediate distances upon separate tracks so located as to facilitate at proper intervals an exchange from express to local and from local to express trains.
3. That the surface of the streets and avenues in the city should be obstructed to the least possible extent, and that wherever surface ground is required private instead of public property should be used, if practicable.
4. That the first lines of railway to be constructed should be on or near the important thoroughfares, coincident—or as nearly so as possible—with the main arteries of travel.

Resolved, That, as meeting these requirements in the manner most feasible for the west side of the city, this board hereby approves of a plan for an underground four-track railway under Broadway, from a point at or near South Ferry to Fifty-ninth street, thence under the Boulevard to a point at or near One Hundred and Sixty-ninth street (with such length of viaduct at and near Manhattan street as may be necessary), thence under Eleventh avenue, or under private property immediately to the west thereof, as may be found most convenient, to such point as the contour of the ground may determine ; thence by a viaduct across Spuyten Duyvil Creek, and by tunnel or viaduct to the city limits.

Resolved, That the general plan of construction from, at, or near South Ferry to near Forty-second street shall be either by double-decked tunnel, with two tracks upon each deck or four tracks on the same level, as may be found upon examination and survey most expedient, the whole to be at such depth below the curb line as not to disturb the surface or endanger building foundations ; from near Forty-second street north to be four parallel tracks upon the same level, as near the surface of the street as practicable when in tunnel, but not in open cut at any point.

Resolved, That the stations for such line of railway shall be upon property acquired for the purpose, and shall be provided with ample elevator capacity wherever the platforms shall be twenty feet or more below the curb line.

Resolved, That the motive power for such railway shall be electricity or some other power not requiring combustion within the tunnel.

Resolved, That the engineers of this board be and are hereby instructed to make the necessary surveys and prepare in detail the plans and specifications for such railway, and submit the same promptly to this board for its further action in finally determining a general plan for submission to the Common Council, in accordance with the provisions of the Rapid Transit act of Jan. 31, 1891.

The work of preparing plans, engineering details, &c., for the Common Council, has been entrusted to the distinguished civil engineer, Mr. William E. Worthen, and Mr. W. B. Parsons, as his assistant. Electrical talent will also be consulted. The Commission, having thus planned for rapid transit on the west side, will now take up the question of rapid transit on the east side.

ELECTRIC METERS.[1]

BY GEO. W. WALKER.

THE time has come for the central station companies to realize that they must supply the electric current in a more thoroughly commercial manner—that is, it must be sold, as other commodities are sold, by measure, weight, or its equivalent. To convince, however, an already skeptical public that the electric current can be measured with as great, if not greater, a degree of accuracy than the established and accepted methods of measuring gas, water, and steam, is no small undertaking. The fact remains, however, that we have to-day a number of electric meters which will measure the electric current more accurately and thoroughly than instruments adopted for similar purposes in other branches of business.

The author then described the various types of meters proposed, as well as those now in actual use, and continued :

The meters which have thus far been described all provide for measuring the amount of current consumed in a culminate manner, either by a series of dials or by ascertaining the amount of metal deposited on an electrode. Therefore any question as to the correctness of the result attained cannot be explained in detail. The gas meter is our legacy, and, strange to say, the efforts thus far made by inventors have been to produce a meter resembling the gas meter as much as possible, both in its appearance and operation. The meter which I will now describe is one with which I am the most familiar and which differs in its operation from any thus far brought to your attention.

It has been usual in testing any electric meter to place in the circuit with the same an ammeter for the purpose of proving the correctness of the meter's operation. Assuming this hypothesis to be correct, we have in the Walker meter the element of a test instrument, inasmuch as the meter consists principally of an ammeter which measures all the current passing and records, by photography, the various positions occupied by the ammeter needle. The use of photography in this case is to eliminate the element of friction in the meter. When I use the word photography I do not wish to imply that there are lenses or any of the necessary devices pertaining to the photographic art to contend with. The apparatus is simply so arranged that the ammeter needle point is represented by a speck of light and as the needle changes its position this point of light traces an image on the sensitive paper which is immediately behind the same. In other words, we are practically photographing the position of the ammeter needle during such time as it is being affected by the passing current, and the result is a continuous line marked upon the sensitized paper representing the fluctuations of the ammeter needle.

In detail the meter consists of an ammeter coil or solenoid, in which an iron wire in the shape of a nearly complete circle is placed as a core. The same shaft to which the circle or core of the ammeter is attached has also fixed thereto a light aluminum sector provided with a fine vertical slot, this slot representing the needle or pointer of the ammeter. Immediately behind this sector is a box which encloses a roll of sensitized photographic paper. The screen placed between the sector and the box has a horizontal slot before which the sensitized roll is made to pass.

The vertical slot in the sector is so arranged as to come at right angles with the slot in the screen, so that in whatever position it may be it will always allow a point of light to pass from the lamp which is enclosed in the meter on to the roll of sensitized paper.

Perforations in the screen representing the calibration of the instrument cause continuous horizontal lines to be printed on the sensitized paper. Another horizontal slot below these perforations is covered by a shutter which is opened every hour by the clock movement and causes vertical lines to be printed across the sensitized paper, representing hours of service. The number of the meter is also printed every hour just above this hour line. Means have been provided for causing a continuous movement of the paper roll at a given speed and this is effected by the use of a small clock movement which is wound automatically by the electro-magnet placed in shunt circuit with the lamp in the meter. The clock movement remains stationary and the lamp goes out when no current is on the circuit, but both start up immediately upon the lighting of a single lamp. In this way there is impressed upon the moving paper roll a complete record, in a detailed manner, of the current consumed in the circuit for a given time.

The roll of paper after a certain time, say one month, is taken from the box and developed in the usual manner, so as to fix the light impressions. It can then be measured up in the same way as an indicator card, by the use of the planimeter. The consumer is, therefore, at any time able to check the charges made, and the records being permanent can be used for future reference. It is evident that a large number of rolls can be developed in the same time required to handle a single one ; in fact, the number is restricted only by the size of the vessel used. In the meter, as at present manufactured, each square inch on the diagram represents sixteen ampere hours, therefore the total number of square inches measured by the planimeter need only be multiplied by sixteen to arrive at the sum total of the energy consumed. The loss in operating this meter is confined to the energy required to burn one lamp in the meter, which, at the candle power used, takes one-sixteenth of an ampere. This is the maximum loss whether the current of one, or one thousand, lamps is being measured, the ratio of loss decreasing as the load increases.

The only care required in operating this meter is in placing the sensitized paper in the holder. In order to do this satisfactorily, a dark room should be built in a convenient portion of the station ; a window of dark yellow glass in this room will provide plenty of light to the operator, but if more light is required, this window can be covered with yellow post-office paper and an incandescent lamp suspended before it. The sensitized paper in rolls of sufficient length for one month's use comes in sealed packages and must only be opened and placed in the holder in the dark room. A boy can be instructed to collect the boxes, as skill is not required. As stated before, the meter number is printed on the diagram every hour; therefore it is not necessary to keep any record of the box itself.

It is evident that a meter which provides means to compute the current consumed in a detailed manner has advantages which other meters do not possess, inasmuch as any question as to the correctness of bills rendered can be satisfactorily explained by referring to the diagram or chart made by the meter which is in dispute.

The patent office reports show numerous devices for securing the record of the ammeter needle on a moving strip of paper by the use of a syphon pen or pencil. In all such cases, however, the element of friction is so apparent as to make their use prohibitive.

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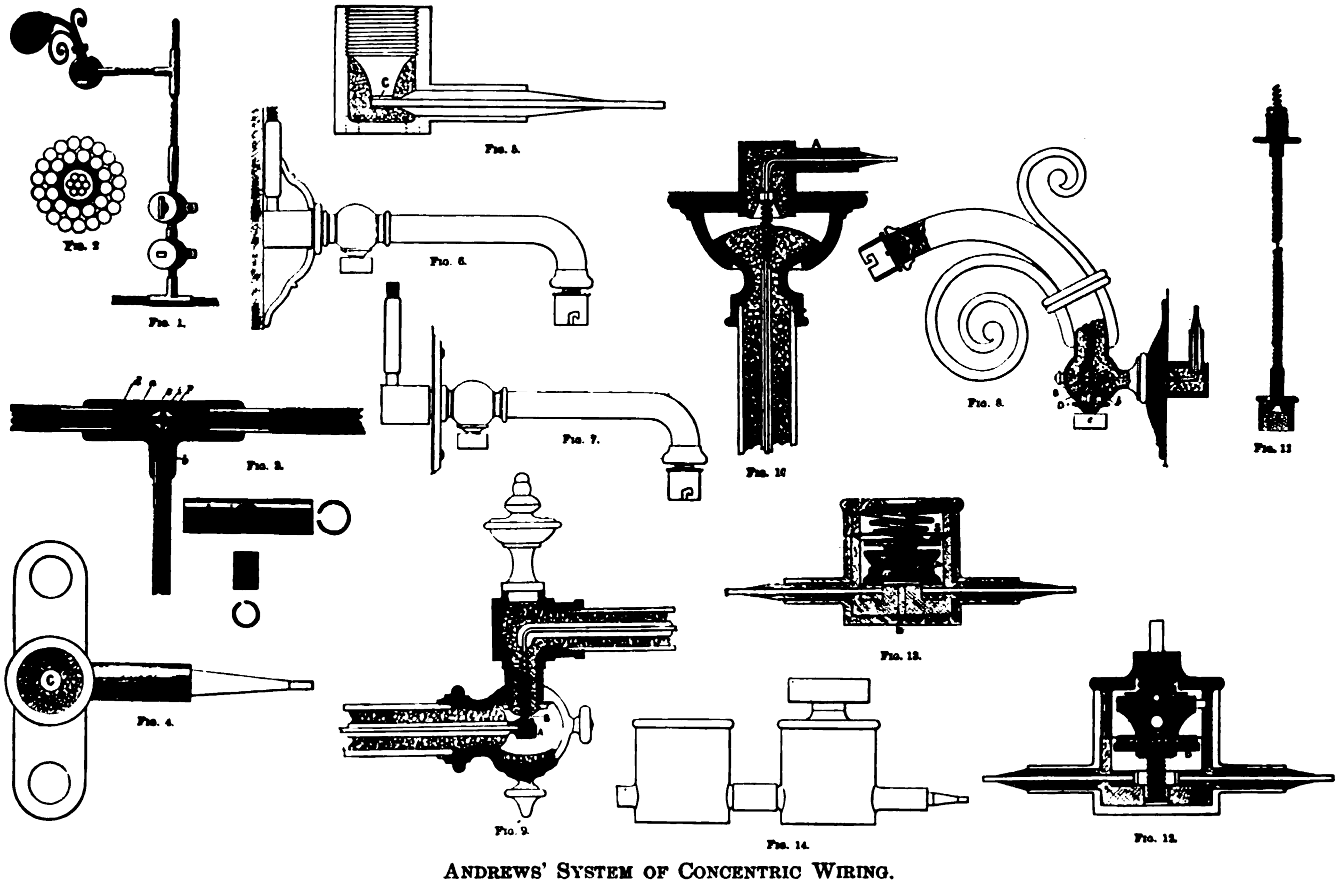
[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, May 21, 1891.

ANDREWS' SYSTEM OF CONCENTRIC WIRING.[1]

THE system of concentric wiring shown in the accompanying illustrations, is not only the result of recent thought and experiment, but has been perfected during several years of gradual development. An idea of the general appearance of the wiring is given in Fig. 1, from which it will be seen that the system resembles more that of gas than what we are accustomed to in the present electric wiring, and it possesses to a marked degree the substantial and simple character in all details that we find in the gas-pipe system, besides having a completely systematic and interchangeable arrangement of all parts. One of the great advantages gained by the system is safety against fire and interruption. This result is gained by the construction of the wire or cable in which the one wire, say, the lead, is completely surrounded by the other, with a waterproof durable insulation between them, and the surrounding conductor is made very heavy as compared with the central, for the purpose of supplying ample metal to secure an absolute short circuit in the case of any fault happening which would generate heat and break down the insulation. The class of wire most employed is copper, with vulcanized india-rubber insulation, armored with galvanized iron wires which form the surrounding conductor. The cross-sectional area of the armoring is usually made seven times that of the central conductor, to maintain the same resistance in both. When the cables are larger, the armoring or outer conductor has to be laid on in two layers, as in Fig. 2, in order to secure sufficient sectional area without increasing the diameter excessively. The smaller size wires, when they are to be laid on the face of the walls, are reduced in diameter to ¼ inch by using copper outer conductors as well as inner, but this is only recommended when the wires are exposed to view. When the wires are to be laid in plaster, they are covered over the outer conductor with a bituminous compound and yarn for protection against possible acids. Beyond this, no protection is used or required. An idea of the exceeding neatness of this mode of wiring may be gathered from the fact that the diameter of a wire to carry five lights is only $\frac{5}{16}$ inch, which takes the place of a wood casing measuring 1½ inches by ½ inch. Larger cables are even smaller in proportion.

The jointing of two lengths of wire together, or of a branch to a main, was a matter of considerable difficulty, which has been entirely overcome in the new joint, of which Fig. 3 represents a section. After preparing the place for the joint by cutting away the outer conductor, and tapering the insulation from both sides, so as to expose the central conductor, C, the inner conductor of the branch, *b*, previously prepared, is joined on and soldered. The insulation is then lapped on, first, a layer of pure india-rubber, P; secondly, an intermediate layer or separation, I, of india-rubber and soapstone; thirdly, a lapping of india-rubber mixed with sulphur, S. The joint thus prepared is wrapped with silesia cloth, *a*, and copper sheaths, *d*, are placed over the spaces cut in the outer conductors. An iron mold is now held round the joint by screws, and a molten metal, fusible at a low temperature, is poured in at a suitable gate; the mold when cold is removed. This method of making good the outer conductor is most effectual. The parts of the joint are completely soldered together, and the heat of the metal thoroughly vulcanizes the india-rubber of the joint. Joints such as these are not only better than the old cast iron or brass box, but they are also much cheaper. The joints, with the fittings, switches, and fuses, &c., and the wires are made in the same way, such articles being provided with a projecting tube and wire. The part of a fitting which is connected to the wiring is called a wall socket, and is illustrated in Figs. 4 and 5. It consists simply of an angle or knee provided with lugs for fixing to the wall or ceiling. A central wire, *w*, attached to a contact, C, passes out of the trunnion, T, and is cut short ready for jointing to the central wire of the leads, as previously described. The contact, C, is held firmly in position by an insulating stone, manufactured for the purpose. This socket may either be fixed to the face of the wall and covered with a hollow plate, as in Fig. 6, or it may be sunk beneath the face of the wall or ceiling with its opening flush with the face, as shown in Fig. 7. Fittings intended to screw into this socket are provided with a male screw end and a projecting spring, as shown in Fig. 8, which makes contact on the contact, C, of the wall socket. This spring is attached to the central wire of the fitting, which terminates in a recessed contact at the other or lamp end, into which may be screwed the lamp direct or a lamp holder. All parts of fittings are constructed with a male and female end, and having started with a fixed female screw in the socket, it is evident that it must always be a recessed end that is left unprotected, thus securing safety against possible short circuits by bridging the contacts at the ends. The insulation of the contacts and springs, and wherever a contact is made, is stone composition of great hardness.

The switch used in conjunction with these fittings is shown in section in Fig. 8. The central wire of the fitting is opened, and made to terminate in contacts, *a*, *a*; a brass disc, B, is placed facing these contacts, and is held from them by a spring, *c*; a cam mechanism, *d*, is provided to move the disc to and from the contacts by turning the handle, *e*; on the stem of this handle



ANDREWS' SYSTEM OF CONCENTRIC WIRING.

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[1] London *Electrical Review.*

there is a cross-head pin, which works on the face of the cam, forcing it to, or from, the contacts according to the direction of turning. A pin, *f*, in the cam works in a wide slot in the frame, and prevents the cam turning beyond the limits of the slot; having a certain latitude in the slot, the cam flies back quickly when the handle is turned towards the off position, thus securing a sharp break of the circuit. The insulation of this switch is throughout the same stone composition as is used at the contacts of the fittings.

Thoroughly practical jointed fittings are exceedingly easily made in this system, as will be understood from Fig. 9. In outer appearance the joint resembles a gas joint. The central wire of one part of this joint terminates in a cup contact, *a*, in which presses a spring, *b*, attached to the contact wire of the other part of the fitting.

Ball and socket joints are of equal simplicity, as will be seen from Fig. 10. A is the usual wall socket, with its recessed contact, B, upon which presses the terminal spring of the central wire. The fitting is hung on a ball joint, C, the centre of oscillation of which is at the contact, B.

Raising and lowering pendants are constructed with two telescopic tubes, insulated from each other with Andrews' patent stone insulation previously referred to. Flexible pendants are also used with this concentric system, and the flexible wire being concentric, has an even, round appearance. These pendants are usually provided with a union junction to screw into the roof or wall socket, as shown in Fig. 11.

The larger switches for operating a number of lights are of similar construction to the one shown in Fig. 8, for a single light; the difference being that the contact disc is made to rotate with the handle spindle, by passing a square prolongation of the latter through a square hole in the disc, *d*, fitted with insulation as shown in Fig. 12. By giving rotation to the contact disc in this manner, a rubbing contact is secured.

The fuse of this system looks like a switch without the handle. It is a brass box, Fig. 13, which forms the outer conductor containing a plug, P, upon which is mounted a tin fuse wire, *w*, attached to contacts fitted diametrically opposite. These contacts, when the plug is in position, meet the contacts of the ends of the central conductors that pass out of the box for connecting to the leading wires. A spring, S, in the cover gives pressure at the contacts. The plug is prevented from turning by a fixed pin, *a*, passing through it to one side of the centre.

Switches and fuses are united together as shown in Fig. 14, for the purpose of making a neater arrangement. The method of making this junction is as follows: The conductors from the contacts of the switch and fuse are tubes concentric with the trunnions of the switch fuse with which they terminate flush. These tubes are connected together by fitting a bundle of hard copper wires tightly into them, and then drawing them together by means of the screw-sleeve on their outer trunnions. This is found to make an excellent connection.

The arrangements of circuits adopted in practice with this system is a facsimile of that employed with gas, the distributing box system, with double wiring, not being found necessary, as the safe nature of the system does not require the introduction of so many fuses. The usual number of amperes to a fuse is 8, or one fuse to every, say, 12 lights, and with a view to securing absolute safety in the event of a short circuit, the smallest wire used is No. 15, S. W. G., it being considered that this size could carry 12 amperes without becoming overheated.

Appointments, Etc.

MR. F. G. STONE is now the superintendent of the Aluminum Brass & Bronze Co., at the Bridgeport factory.

MANAGER B. B. NOSTRAND, JR., of the Sing Sing, N. Y., Electric Lighting Company, has accepted a similar position with the Peekskill Electric Light and Power Company, and will, in future, look after the interests of both companies.

ELECTRICIAN HINCKLEY, of the Citizens' street railway, Indianapolis, Ind., has resigned because Mr. Shaffer was forced out of the presidency. The company has chosen as his successor Maj. Jewall, who put in the Kansas City line. Mr. Jewall has been in the city looking at the proposed new Irvington line, and has gone to Pittsburgh to examine some ideal electrical work there. The Irvington line is to receive his first attention upon his return.

ELECTRICAL CRANES FOR SOUTHAMPTON.

The harbor authorities of Southampton, England, the great mail port, have decided to adopt electrical cranes for the unloading of vessels, on account of the greater rapidity with which they will enable work to be performed.

Reports of Companies.

FORT WAYNE ELECTRIC CO.

The net earnings of the Fort Wayne Electric Company for the past six months have amounted to $215,000, or $95,000 over and above the amount required for the semi-annual dividend. This is equivalent to more than 5 per cent. on the total capital of $4,000,000. The previous six months yielded $161.206, or about 4 per cent., so that the entire income for the year has been something over 9 per cent., of which 6 per cent has been paid out in dividends.

College Notes.

PURDUE UNIVERSITY.

The engine and dynamo room of the electrical laboratory of Purdue University now contain a 22 h. p. Straight Line engine, a Brush and a Thomson-Houston arc, and an Edison incandescent dynamo, and a Sprague and a Baxter motor. There is also a Slattery alternating dynamo with a bank of converters for the study of alternating currents. The dynamos, as well as a Julien storage battery plant, are connected with a convenient switchboard, so that measurement work may be carried on in any part of the building. A Brackett cradle dynamometer is used in testing efficiency. The construction of a dynamo, wound compound, series, and shunt, for experimental study, has been begun.

THOMSON-HOUSTON WORK IN FRANCE.

The lighting of St. Briené, France, by the Thomson-Houston Company excites considerable interest among technical men, says our London correspondent. This company has hitherto had in France only installations for direct current; now it has completed its first installation with alternating current and transformers. A waterfall at Pont Neuf, twelve kilometres distant, is utilized. Among other peculiarities, is the coupling in parallel of alternators by means of a choking coil, and the compounding of the alternators, in order to maintain constant difference of potential at the end of the feeders, notwithstanding a fall of potential of 20 per cent. when the alternators furnish the maximum current of 35 amperes each.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of May 30, 1891, from New York, Boston and Washington.

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80	Edison Gen. Elec. Co	101¼
American Tele. & Cable	83	Edison Gen. Co. Def'd	....
Centl. & So. Amer	135	Consol'd Elec. Lt. Co	...
Mexican	200	Edison Illu'g Co. N. Y	76
Com. Cable Co	105	U. S. Elec. Lt. Co	30
Postal Tel. Cable	30	North Am. Phonograph	..

BOSTON.

	BID.		[illegible]
Thomson-Houston	43	Ft. Wayne Co	[illegible]
" Pref'd	25¼	Am. Bell	[illegible]
" Series C	8¼	Erie	[illegible]
" " D	7	New England	[illegible]
" Int. Co	....	Mexican	[illegible]
Thomson Welding Co	....	Trop. American	....
Thomson Eu. Welding	60	Edison Phon'gph Doll	[illegible]

WASHINGTON.

	BID.		BID.
Penna. Telephone	25	U. S. Elec. Lt (Wash)	158
Ches. & Pot. Telephone	61¼	Eck.&Sold. Home Elec. Ry.	49¼
Amer. Graphophone	5¼	Ge'rget'wn & Tennallyt'wn	57

PITTSBURGH.

Westinghouse El. & Mfg. Co	13¼

THE WESTINGHOUSE MULTIPOLAR RAILWAY GENERATORS.

The demand for large, slow-running generators for street railway work is constantly increasing as their advantages become more generally known and appreciated. To meet this demand, the Westinghouse Electric & Manufacturing Company is now building a compound-wound, multipolar generator, which at present is built in three sizes, namely, 125, 250, and 500 h. p.

As will be seen in the accompanying engravings, these generators resemble in general design the well-known Westinghouse alternating current dynamos. There is the same cylindrical yoke parting along a horizontal plane through the shaft, and the same arrangement of inwardly pointing pole pieces, but with a much smaller number of the latter.

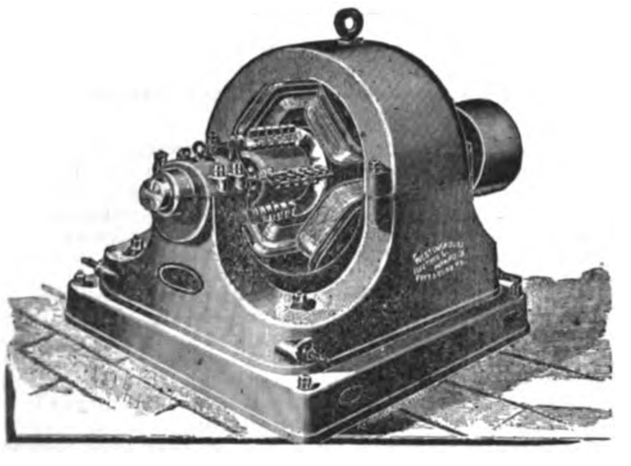


FIG. 1.—NEW WESTINGHOUSE 4-POLE RAILWAY GENERATOR.

The 125 and 250 h. p. machines have, as shown in Fig. 1, four pole pieces, and in the 500 h. p. size, Fig. 2, there are six poles. In this latter machine the shaft has a bearing outside of the pulley, which relieves it in a large degree of the bending strain, and adds much to the rigidity of the armature.

The pole pieces are built up of thin sheet-iron plates bolted together and cast into the cylindrical yoke. The shunt and series coils are wound side by side upon metal bobbins, which are then slipped over the pole pieces and held in place by bolts. The insulation of these coils, as well as that of the armature, is of ample thickness and of superior quality.

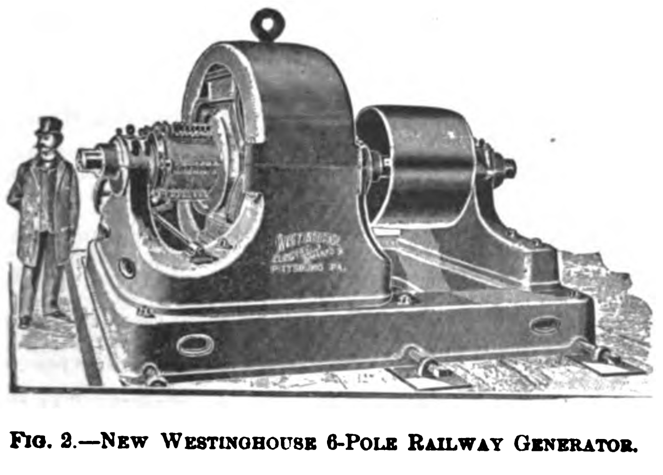


FIG. 2.—NEW WESTINGHOUSE 6-POLE RAILWAY GENERATOR.

The bearings are self-oiling as well as self-aligning, and a large amount of bearing surface is obtained owing to the length and large diameter of the journals.

The armature is of the Gramme ring type, the core being laminated in the usual manner. The armature and series coils are wound with wire of large capacity, and, as a consequence, the heating effect is almost unnoticeable, and the electrical efficiency of these generators is claimed to be from 94 to 96 per cent. at full load. These generators are wound for 500 volts, but they can be worked up to 550 or even 600 volts with the same armature speed, by throwing resistance out of the shunt circuit by means of the hand regulator.

The excellent design of these generators is probably most apparent in the matter of regulation. The action of the series coils is such as to cause a considerable rise in voltage, as the current being drawn from the machine increases. It is claimed that even at full load this rise in voltage is sufficient to make up for any ordinary loss or "drop" in the line.

The number of sets of brushes corresponds to the number of pole-pieces, and the alternate ones, being of the same polarity, are connected together. Each individual brush has its own spring by means of which its pressure on the commutator may be adjusted, and any one of them may be removed without disturbing the others. The dynamos may be run in either direction.

We also give a view of a railway switch-board, Fig. 3, equipped with Westinghouse appliances, some of which, such as the circuit breaker and lightning arrester, have already been described in detail in these columns. This board accommodates three generators and three feeders.

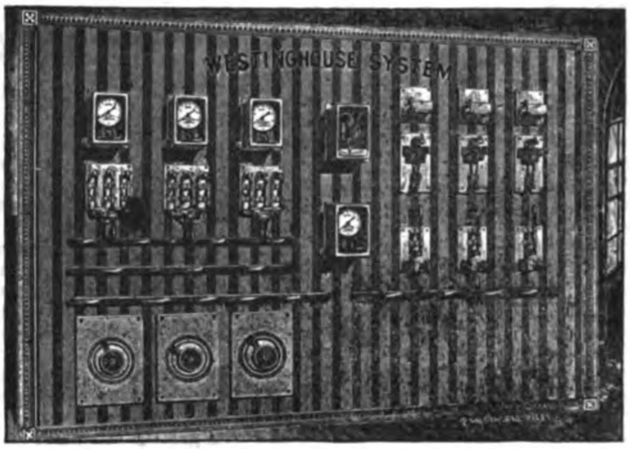


FIG. 3.—WESTINGHOUSE RAILWAY SWITCHBOARD.

ARC LAMPS AND LARGE INCANDESCENTS.

At a meeting of the South Wales Institute of Engineers, writes our London correspondent, Mr. Polybank gave some interesting particulars of his experience with arc lamps and with large incandescent lamps of the Sunbeam type, at Swansea Docks. He had found that a 2,000 candle-power 10 ampere arc lamp, with two 11 mm. carbons 11 in. long, would burn only 12 hours with proper current. The cost of such a lamp, taking 10 amperes at 50 volts, and working from sunset to sunrise throughout the year, or about 4,874 hours, was £15 18 7. The globes surrounding the carbons cost 10s. to 12s. each, and sometimes broke, but no allowance had been made for this. Comparing such a lamp with a 500 candle-power Sunbeam lamp, the workmen very much preferred to work with the latter, as it gave a steadier light and was not so trying to the eyes. The average length of life of these lamps was about 1,500 hours, though some had broken down after only 400 hours' work. The total cost of working was £11 19 0. The lamps, when first put up, took 10 amperes at 100 volts, but after the lapse of from 800 to 1,000 hours the current was reduced to 8.5 amperes. The bulbs blackened somewhat, but not so seriously as might be imagined, as some lamps which had been burning over 2,000 hours still gave a fairly good light, which proved satisfactory to the workmen.

THE TROLLEY SYSTEM IN CLEVELAND.

Taking up and answering some criticisms of the Providence *Telegram* on the trolley system, the *Cleveland Plain Dealer* says: "The trolley system has been the greatest boon to Cleveland. It has developed suburbs, made possible the building of the thousands of small homes east, south and west and been a great factor in the 10,000 a year increase of population during the last decade. It is by no means a perfect system, but it is the best that inventive genius affords to-day. A few citizens of Providence should come out of their dens and see the world. Let them come to Cleveland and we will show them what a live city is and what an efficient street railway looks like."

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER *150 Broadway, New York city.*

THE REFLECTING GALVANOMETER: YOUR ABUSE OF IT AND ITS USE TO YOU.

When I come to reflect, I think I can spot the author of an article, which appeared in one of your contemporaries recently, entitled "Abusing the Galvanometer." But luckily, hard words break no bones, and, although I confess to being a "dead beat," shining by borrowed light, still the scale of his abuse compels me to offer some resistance to the charges he has made against me. I will try to negative the assertions current throughout his positively unmerited abuse, and strive to clear myself of the constant errors he so dogmatically attributes to me. Had he used a well-designed and scientifically constructed galvanometer he would have written otherwise, and herein is to be found the key of his tone.

I admit that there are some disreputable gals. whose sole value lies in the amount of polished brass, glass and lacquer they possess. If he has been using one of these highly finished nondescripts with unsteady base, the centre of gravity of whose astatic system is badly positioned on a long suspension, with soft watch spring magnets, the force of which is, on the slightest pretext, ready to become reversed or weakened, then I will allow that the unjustifiable bad temper of the steel will justify a worse one in the electrician.

But what are his worries and troubles compared with those of a really good gal. in the hands of a bad electrician?

Just a word from my side of the question, if you please! I have been sworn at until I trembled in every fibre because my shunt has been left open, and a current from 500 cells has therefore literally "knocked spots out of me," and so thoroughly upset me that I didn't know which way to turn!! Then when the brainless individual discovered his blunder he has petted and patted me, and tried his vapid best to bring me round, and, not succeeding, has shaken me like a dice box!! Finally he has given me up in despair, and then I, always anxious to do my best, according to the power given me, have, when left alone come round gradually of my own volition.

He has used the most frightful language to me because he could not find the spot. He has taken me off my stand, opened me and ruined my fibre, to find out why I would not indicate, and replaced me with a bang and another explosion of temper, which lasted until his "grey matter" became active enough to show him that my lamp had gone out or perhaps had never been lit! He has sent currents of from one to 1,000 volts through me until my mirror has become statically rigid, and then, what wonder if I do "kick" at times and fly off the scale?

It is hard to have a fellow stamping like a mad bull because he gets no sign of life from me until he remembers he has left out the battery plug!! If, also, he will insist on putting down the wrong key, what can I do but keep quiet? And what can a sensitive, delicate gal. do to quell an atmosphere of sulphurous invocations and anathemas, proceeding from an ovoid brained fellow who hasn't sense enough to find out that I am disconnected somewhere, who is too dense to be able to distinguish between an intermittent and a permanent disconnection; and who, when things come right by accident, is stupid enough to be content and trust that things will keep right, until he bursts forth in another rage because, at a most particular moment, I can't help going wrong?

How can I be expected to give reliable results when placed on a foundation of eggshells, fish bones and old tomato cans, and am bombarded on all sides by flying machinery, and demoralizing inducements to go wrong, from pigs of iron whose position and duty is to elevate even an elevator? If I am placed in a position where temperature ranges from boiling to freezing point, am I to blame because, when shrivelled and contracted, or relaxed and languid, I cannot always give the same result?

No, Sir. When things are so bad as the writer in your contemporary would have us believe, it is either that he does not know his work, or that his galvanometer is but a sham and shoddy imitation. Possibly it may be both causes together! In the hands of a competent man I am undeniably, although perhaps a little touchy and supersensitive at times, the most delicate and absolutely reliable instrument of physical research on earth. And the man who, from ignorance or choice, "imperils his hereafter," by the use of a worthless gal., deserves to go where Charity teaches us to hope Lady Macbeth is not. If he is *compelled* to use it, then his redemption has been wrought down here; he has earned the indulgence of St. Peter for all sins short of murder, and the old Saint would probably look even on that as a virtue if the victims were the makers or the owners of the instrument, and would at once admit him to those regions of bliss where cables are unknown and the weary electrical engineer knows no drop of potential!!!

A.

European Correspondence.

LONDON.

Royal Society's Conversazione.—Electric Light Litigation.—Electric Light in the City.

THE annual conversazione of the Royal Society was held last week, at Burlington House. Sir Wm. Thomson, the president, received the numerous guests. The new Wimshurst electrical machine was exhibited, but in this case the essential parts of machine consisted of one rotating disc and four inductor plates, each having its own brush, and convertible into a machine capable of supplying a large and constant electric flow.

Professor Oliver Lodge showed a rotating mirror driven at a high speed, designed for analyzing the electric spark, and for observing the speed of electric pulses along conductors of various kinds. He had also a pair of resonant Leyden jar circuits. One circuit was fed from a Wimshurst machine and when sparking took place a similar effect was produced in the other circuit which was several feet away and quite isolated from the first circuit. Mr. W. Crookes exhibited his set of tubes for exhibiting phosphorescence in high vacua, and which formed the subject of the inaugural address to the Institution of Electrical Engineers. Mr. Shelford Bidwell demonstrated the action of light in modifying the electrical resistance of selenium. An electric lamp was lighted, a bell rung, and other effects produced by merely shading the beam from a lamp. This beam was directed on to a selenium cell made of two fine copper wires wound very close together on a slip of mica one side of which was coated with a thin film of selenium. A current flowed through the coils of a relay, and was greater when the light fell on the cell than when it was shaded. The alteration in the resistance of the selenium brought about the action of the relay, and the main current was turned on or shut off as the case might be.

An electric supply company in London has been summoned under the Act for refusing to supply a customer during the daytime with the electric light. The case when brought before the courts should present some peculiar points in electric light legislation.

Electric lighting in the city is pushing on. The central station at Meredith's Wharf, Bankside, is nearly ready to receive the machinery. Mains have been laid in Queen Victoria street, and the iron standards erected. It is said that the first lighting will take place next month.

H. S.

LONDON, May 13, 1891.

Electric Launches.—Reduction in Telegraph Rates.—Ship Wiring.

ORDERS for electric launches are being sent to the London firms in profusion. Among them may be mentioned a boat 40 feet long for the Russian Government, to be built by the General Electric Traction Company.

It is anticipated that the recent reductions in Australian telegraph rates will cause an extraordinary influx of telegrams; to meet the expected demand the cable companies have prepared by laying new cables.

It is stated that the contract for the electric cars at Barking Road has been renewed with the General Electric Traction Company at an increase of 1*d* per mile, which brings the price per car mile to 5½*d*.

In his lecture on "Electric and Magnetic Screening" at the Royal Institution, Sir Wm. Thomson condemned the use of the "single wire" system of lighting ships by electricity, on the ground that observation has shown it to produce an error in the ship's compass of 3 degrees to 7 degrees, in spite of every care being taken. It has been argued that the iron hull which completes the circuit in the single wire protects the compass from the deflecting influence of the current, but Sir William declared that this argument was fallacious. In order to do so with any degree of success, the hull and decks of the ship would have to be several feet thick of iron. Even in the conning tower of Her Majesty's ship *Orlando*, which is belted with iron one foot thick, the terrestrial magnetic force on the compass is only reduced to one-fifth of what it is outside.

H. S.

LONDON, May 2, 1891.

Legal Notes.

THE EDISON LAMP LITIGATION.

The suit of the Edison Company against the United States Electric Lighting Co. for alleged infringement of the Edison electric lamp patent, usually known as the carbon filament patent, which came up for hearing in the United States Court before Judge Wallace in this city on May 25, is perhaps the most important, in view of its relations to the entire industry of incandescent lighting, of any of the various suits now pending between the principal electrical interests. It was commenced as long ago as 1885; eminent counsel have been employed on both sides, and a vast amount of evidence, filling half a dozen large printed volumes, has been taken. The issues are substantially the same in this case as in those already tried in England, and in which the Edison patent, after some vicissitudes, was ultimately sustained. The differences, not only in the law, but in the state of facts as presented by the evidence, from those in the English cases, render it rather difficult, however, to predict the ultimate result.

The case was opened on Tuesday by Mr. Richard N. Dyer, who spoke for two days in behalf of the Edison Company. His argument was that the invention of Edison was the foundation of the modern incandescent lighting system; that it consisted in placing a carbon filament of high resistance and small radiating surface in an exhausted glass globe. He reviewed the state of the art at great length, and claimed that prior to the date of Edison's discoveries, inventors had been following the wrong track. His presentation of his facts was admirable, and was heard with great interest. The case for the defence was opened on Thusday by Gen. S. A. Duncan. The argument of Gen. Duncan was acknowleded by all to be a most masterly effort; his points were presented with great skill, and ably supported by an array of facts, in which no feature, however small, appeared to have been overlooked. He contended that Edison's invention, in view of the condition of the art, showed little that was new; and even admitting the importance of the features of the high resistance and small radiating surface, in an incandescent burner inclosed in a vacuum, that these then were all found in a prior application made by Edison himself. He adverted to certain papers in the Patent office which, he alleged, showed that the Edison Company itself did not regard the patent in suit as covering the invention which it is now sought to embrace within it.

The arguments are in progress as we go to press.

Obituary.

DAVID BROOKS.

The death of the veteran electrician, David Brooks, occurred at Philadelphia, on May 30. He was born at Brooksvale, near Cheshire, Conn., on January 26, 1820. He left college at the age of twenty years, and took a place as instructor in mathematics in the United States Navy. At this time Professor Morse and his associates were engaged in their first experiments with the electric telegraph. Mr. Brooks left the Navy in 1845, to devote himself to the development of this great invention. During that year he put in operation, in connection with James D. Reid, the first telegraph line built in America after Professor Morse's experimental line between Baltimore and Washington. This ran from Lancaster to Harrisburg, Penn., and Mr. Brooks received the first message sent over it. In the following year he built the line across the Alleghanies, connecting Philadelphia and Pittsburgh.

From 1854 to 1867, David Brooks was in the service of the old Atlantic and Ohio and the Western Union companies. In the latter year he resigned, and devoted himself to his many inventions and improvements in telegraph and telephone service. In 1873 he was appointed by General Grant United States Commissioner to the Vienna Exposition. Mr. Brooks' inventions have been of great importance in the development of telegraphy. The deceased was a vigorous writer, not slow to take his share in any controversy going. The last articles that he wrote were prepared specially for THE ELECTRICAL ENGINEER, and were published in these columns during May.

EDWARDS H. GOFF.

The death is announced of Edwards H. Goff in this city. Mr. Goff was at one time quite active and prominent in electrical matters on account of his association with Thomson-Houston interests in New England and afterwards through his presidency of the American Co., which owned the Fuller-Wood system. After the collapse of his electrical enterprises, he became interested in the *Daily Graphic*, and at the time of his death was engaged promoting the American Export and Trading Co., a concern whose business it was to develop and control trade with South American countries. Mr. Goff was a man whose readiness to lend his name and wonderful energy to all manner of visionary and doubtful enterprises led him into many troubles and disasters, in which others often became seriously involved. It deserves mention that he presented a complete electric lighting plant to the Government to be used for the Bartholdi Statue of Liberty, in New York Harbor.

Society and Club Notes.

HIRAM S. MAXIM BEFORE THE NEW YORK ELECTRIC CLUB.

"The Tools of Modern Warfare" was the subject of a lecture delivered last Thursday night before the Electric Club by Hiram Maxim, the well-known electrical pioneer, and the inventor of the Maxim gun. Mr. Maxim first briefly described the old brown and black gunpowders, and then followed with a description of the smokeless powders just coming into general use. Samples of each powder were fired. Next he showed the evolution of the modern rifle, beginning with the flint lock of the Revolutionary period, and continuing through the old percussion lock, the Springfield rifle, which had to be cocked by hand every time it was fired; the Remington, the Peabody or Martini-Henry, the Lee, the Winchester, the Colt, the Mannlicher, and the Birdson.

Mr. Maxim's description of his own arm, the Maxim, was illustrated by one of the guns, which was mounted in the parlor. A tube was arranged so as to carry the gases up the chimney, and at a signal forty-nine shots were rattled off more rapidly than they could be counted or timed. Two shots were fired so rapidly that but a single report was heard. Then the inventor played "Tom, Tom, the Piper's Son," each note being sounded by a shot from the gun. This was done to show that the gun can be fired as regularly or as irregularly as desired. From a forty-pound gun of this type 1,001 shots have been fired in one and a half minutes. It is now used in nearly all the armies of Europe.

The lecture was intensely interesting, and aroused so much discussion and talk that time did not admit of any description by Mr. Maxim of his experimental work in aerial navigation as carried on by him in England, where he is now residing. Among the participants in the discussion was Dr. Gatling, the inventor of the Gatling gun.

After the lecture, Mr. Maxim held a kind of informal reception, and renewed acquaintance with many of his old friends in the electrical field.

The next meeting of the Club will be held some time in June—probably the third Thursday—and will take the shape of a smoking concert, being the first effort of the Club in this direction. It is proposed not to go outside electrical circles for talent, and the Entertainment Committee have been agreeably surprised to find an abundance of musical skill at their disposal. The programme will also be reinforced with some electro-harmonic novelties, of which due notice will be given.

At the last meeting of the Club Board, thirty-one active and associate members were admitted. These added to the round score admitted in April, and the 42 now applying, show a gain of nearly 100 members within three months—a big step forward that must be very gratifying to Presidents Madden and Insull and those who have been co-operating with them to put the Club on the right basis.

FRANKLIN EXPERIMENTAL CLUB, NEWARK.

At the last regular meeting of the Franklin Experimental Club, May 19, 1891, Prof. Geo. C. Sonn delivered an intensely interesting and instructive lecture on "Seismology," or phenomena of earthquake disturbances and methods of studying the same. Prof. Sonn dwelt upon the various theories prevalent, upon the subject of earthquakes, tidal waves, etc., and explained the methods adopted from the earliest times to the present day in the study and recording of the various disturbances going on in various parts of the earth's structure. The lecture was illustrated by magic lantern views of the most important earthquakes and their effects in Japan, Java, Sandwich Islands, Lisbon, Charleston, and elsewhere, and also by diagrams, prepared by Prof. Sonn, of the electrical and other methods employed in recording the time and duration of the disturbances, and the number and general character of the movements.

Some interesting pictures were shown of various buildings and the effects of the shocks upon structures placed in certain positions, and he explained that as nearly all of the impulses moved in one direction, it was customary in earthquake countries to pass strong laws stating how buildings were to be set, whether windows and doors, etc., would be allowed in walls which ran in certain directions, relative to the seismic movements, the character and material employed. The President exhibited some interesting samples of lava, and earthquake souvenirs, collected by him at Herculaneum, Pompeii, and the Island of Iskia. Prof. Sonn sails for Europe shortly, and during his visit abroad will visit the Electrical Exhibition in Frankfort, and will prepare an interesting report for the Franklin Experimental Club.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 26, 1891.

Alarms and Signals :—

Police Signaling Apparatus, H. A. Chase, 452,771. Filed July 18, 1890.
Includes a special form of ground-detector, located at central station; also a special construction of signal transmitters.

Electro-Mechanical Gong, F. W. Cole, 452,981. Filed Dec. 9, 1890.
A quick-acting gong.

Electro-Mechanical Gong, F. W. Cole, 452,982. Filed Dec. 9, 1890.
Details of construction and operation. A part of the releasing mechanism serves as a retractor for the armature of the electro-magnet.

Clocks :—

Electric Transmitting Clock, H. S. Prentiss, 452,955. Filed June 6, 1890.
Relates to electro-mechanical clocks, and especially to the connections of the primary clock with the transmitter.

Synchronizer for Electric Clocks, H. S. Prentiss, 452,956. Filed June 6, 1890.
A switch actuated at determined intervals breaks contact at the main line and closes it through a synchronizing line.

Dynamos and Motors :—

Electric Motor, C. J. Kintner, 452,795. Filed June 14, 1890.
A motor designed especially for use with revolving fans.
The field-magnet core is divided at its neutral point. The vertical armature shaft has a longitudinal movement in its journal bearings; the fan is attached to the lower end of the armature shaft.

Electric Motor or Generator, W. K. Freeman, 452,984. Filed Jan. 13, 1891.
Relates particularly to the form and construction of the frame and field magnets.

Electric Motor or Generator, W. K. Freeman, 452,985. Filed Jan. 13, 1891.
Relates to frame and field magnets, their form and construction.

Electric Switch, W. K. Freeman, 452,987. Filed Jan. 15, 1891.
A rheostatic switch for the control and regulation of motors.

Armature for Dynamo-Electric Machines or Motors, E. Thomson, 452,951. Filed March 5, 1890.
A construction for ring armatures designed to facilitate the winding and replacing of the armature coils.

Electric Motor, E. Baker, 453,081. Filed July 5, 1890.
Designed to run upon an elevated track for carrying small parcels. Has its armature inclosed within the driving wheel and its field magnet suspended beneath the track.

Automatic Electric Switch Mechanism, H. H. Blades, 453,082. Filed Sept. 19, 1890.
An automatic rheostatic switch for controlling and regulating the introduction of current to electric motors.

Lamps and Appurtenances :—

Incandescent Electric Lamp, I. J. Flagg, 452,780. Filed Sept. 17, 1890.
Relates to water and moisture-proof insulating material within the socket.

Hanger for Incandescent Lamps, J. A. Matteson, 452,799. Filed Dec. 24, 1890.

Adjuster for Electric Lamp Reflectors, J. E. Hamilton, 453,008. Filed Jan. 3, 1891.

Electric Display Burner for Oil-Lamps, W. A. Drysdale, 453 041. Filed Feb. 16, 1891.

Device for securing an incandescent electric lamp upon an ordinary form of oil lamp.

Measurement :—

Electric Meter, W. K. Freeman, 452,986. Filed Jan. 13, 1891.

An electric motor meter. As the increase in the rate of revolution of the armature is not directly proportional to the increase of current the mechanism connecting the motor with the registering dials includes a revolving member circular in cross section but with a longitudinal contour corresponding to the characteristic curve of the motor. The motor shaft and the shaft carrying the curved members are in a vertical position and the latter carries at one end a fan propeller revolving in a homogeneous liquid; it has freedom of movement longitudinally and is raised or lowered through the action of the fan propeller. The movement of the registering apparatus is controlled by the position, higher or lower, of the shaft carrying the curved member.

Metal Working :—

Art of Repairing Metal Structures by the Aid of Electricity, E. E. Ries, 453,164. Filed Nov. 9, 1889.
Employs the process set forth in the same inventor's patent of Sept. 20, 1887, No. 370,282. The present invention consists in cutting out a defective portion or section of a metallic structure, inserting a new portion or section and electrically welding at the ends or edges.

Miscellaneous :—

Hollow Braided Lightning Rod, G. R. Kress, 452,796. Filed Nov. 8, 1890.

Multiple Fuse Block, L. B. Favor, 452,875. Filed Nov. 3, 1890.
Improvement upon the construction shown in the same inventor's patent of July 1, 1890, No. 431,186.

Grounding Device for Lightning-rods, C. M. Radford, 452,983. Filed Jan. 19, 1891.
A terminal adapted to be readily driven into the ground.

Multiple Cut-Out for Electric Distribution Systems, E. P. Warner, 453,089. Filed Feb. 6, 1891.
Applicable to multiple-arc distribution. Designed to reduce the number of manipulations required.

Adjustable Support for Electric Wires, T. H. Brady, 453,036. Filed Feb. 18, 1801.
A bracket adapted for use as a right or left-hand bracket or as a hanging or standing bracket; avoids the necessity of special brackets for different uses.

Electrical Safety Switch, G. L. Hall, 453,046. Filed Mar. 19, 1890.
Designed to open a line at one or more points upon a failure of the current.

Electric Fuse Box, W. Edson, 453,111. Filed Jan. 21, 1891.
A multiple fuse-box. If a fuse burn out another may be substituted by a simple movement.

Railways and Appliances :—

Automatic Safety Electric System for Locomotives, E. Deming, 452,871. Filed Sept. 18, 1890.
Electro-mechanical devices for automatically applying the brakes of a railway train, and simultaneously closing the throttle valve of the locomotive.

Automatic Safety Electric System for Railways, E. Deming, 452,872. Filed Sept. 20, 1890.
An electro-mechanical system for stopping automatically one or more trains when dangerously near each other, and to do so independently of the engineer.

Automatic Electric Safety System for Railway-Switches and Draw-bridges, E. Deming, 452,873. Filed Sept. 22, 1890.
An electro-mechanical system for stopping a train automatically when within a predetermined distance of an open draw-bridge or an open switch.

Automatic Electric Safety System for Railway-Crossings, E. Deming, 452,874. Filed Sept. 24, 1890.
For automatically stopping a train within a predetermined distance of a crossing when another train is at, or near, the crossing on another track.

Electric Railway, R. M. Hunter, 452,980. Filed Apr. 28, 1888.
Includes two or more electric motors upon a car, reversible commutator brushes for each motor, means controlled by the operator for actuating the brushes to reverse the motor, resistances in the motor circuit and automatic control of such resistances.

Air Brake System, W. W. Slater, 452,942. Filed Mar. 19, 1890.
An elecro-magnetic system for controlling air-brakes.

Electric Motor for Wheeled Vehicles, R. S. Dobbie, 432,992. Filed May 9, 1890.
An electric motor elastically supported, has its rotary part secured to a sleeve which surrounds an axle of the vehicle, and is provided with elastic or yielding bearings at its opposite ends between it and the axle.

Support for Trolley Wires, G. K. Wheeler, 453,070. Filed Nov. 21, 1890.

Trolley Wheel, J. Sullivan, 453,091. Filed Feb. 19, 1891.
A special construction, adapted to break up and dislodge ice or snow accumulating upon a trolley wire.

Electric Railway Signal, W. C. Walter, deceased, S. L. Walter, executrix, 453,097. Filed Nov. 11, 1889.
A system of circuits and signals by which the engineer of a train will be notified if a switch is open or if the rails have spread or if a bridge has settled ahead of him, and by which also the engineers of two trains on the same track are placed in communication.

Insulating Clamp for Span Wires, W. E. Baker & C. H. Mackloskie, 453,100. Filed Jan. 9, 1891.

Electric Contact Brush, J. R. Branch, 453,104. Filed Oct. 28, 1890.
Designed as a substitute for trolleys upon electric railways.

Electric Locomotive or Street Car Motor, R. Eickemeyer, 453,167. Filed Oct. 28, 1890.
Application of the same inventor's peculiar motor to railway service. The armature shaft of a slow speed motor is directly connected to the driving wheels or their axle by a pitman.

Telegraphs :—

Sextuplex Telegraph, T. A. Edison, 452,913. Filed June 2, 1877.
For the simultaneous transmission of three messages in opposite directions from each end of a single line. Of the three receiving instruments at each end one responds to reversals, another responds to a current of either polarity that is above a medium strength, and the third responds only to a current of maximum strength.

Telephones and Apparatus :—

Telephone Receivers, C. T. Dickson, 452,775. Filed Aug. 14, 1890.
An addition to an ordinary telephone receiver of a flexible tube, one end of which leads from the air space in front of the diaphragm and the other is terminated with an ear-piece. The listener uses the receiver in the ordinary manner at one ear and the ear-piece at the end of the flexible tube at the other ear.

Coin-Controlled Annunciating Machine, H. M. Hamrick, 452,785. Filed Feb. 24, 1891.
A "nickel-in-the-slot" device for use at telephone pay-stations.

Electrical Switch-Board, J. B. Lyon, 452,921 Filed Jan. 19, 1891.
Relates to the weight and cord-guides employed in telephone switch-boards of the type known as the "Law system." A section of guide-tubes, consisting of a group of rubber tubes, provided with electrical contacts, is made integral by vulcanizing the entire group after assemblage.

Electric Connection for Distributing Telephone Lines, W. M. Goodrich, 453,000. Filed Feb. 7, 1889.
Relates particularly to multiple switch-board apparatus.

NEW YORK SUBWAYS.

Ex-Alderman Walton Storm, the newly appointed Commissioner, took his seat at the last meeting of the Board of Electrical Control. The engineer, Mr. Kearney, reported the completion of a number of subways. The secretary, on motion of Commissioner Hess, was instructed to inform the subway companies that work on all subways heretofore ordered must be begun before June 15 and completed by December 15. If this instruction is not obeyed, the resolution averred, the companies' bonds will be forfeited.

ELECTRIC RAILROADING IN ENGLAND.

The directors of the South Staffordshire Tramway Company, writes our London correspondent, have issued a pamphlet in which are set forth from various points of view, the advantages of electric traction over steam traction for tramway purposes. After stating that there are many considerations which make for the final and complete superseding of the latter method by the former, and that the authorities both of Glasgow and Leeds have extensive schemes in hand, the directors add that they have seriously considered the objections raised by the local authorities to the use of steam, and after carefully investigating the various other methods of traction they are prepared to recommend the shareholders to adopt the overhead system of electric traction.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

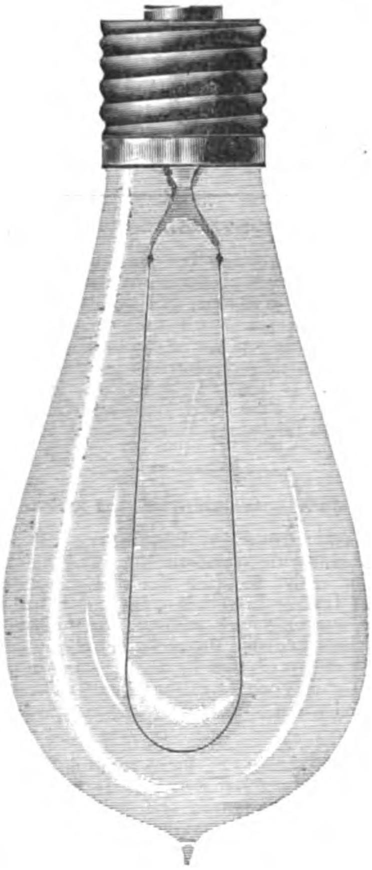
Advertise so that when a consumer wants goods in your line, he thinks at once of yours.

THE JEWELL INCANDESCENT LAMP.

We illustrate in the accompanying cut the Jewell Incandescent Lamp, for which Mr. William Hood, of Chicago, is the general agent. This lamp is the outcome of prolonged experiment, and although it has been on the market but a short time has given most remarkable and excellent results in practice.

The filament used in these lamps is remarkable for its great tensile strength and the entire absence of any discoloration due to the action of the current after it has been running for any length of time. It is made from the very best raw material and subjected to a special treatment which gives it all the properties so desirable in a reliable and efficient incandescent lamp, and it is stated that it requires less power for an equivalent amount of light than the average lamp, maintaining its normal candle power through the whole life of the lamp, which is not less than 800 hours.

The manufacture of these lamps is being carried out on an extensive scale, and the factory has been thoroughly equipped with all the new and most perfect apparatus necessary in the production of a high grade lamp; and infinite care is taken through every process of manufacture to produce a uniform and perfect product.



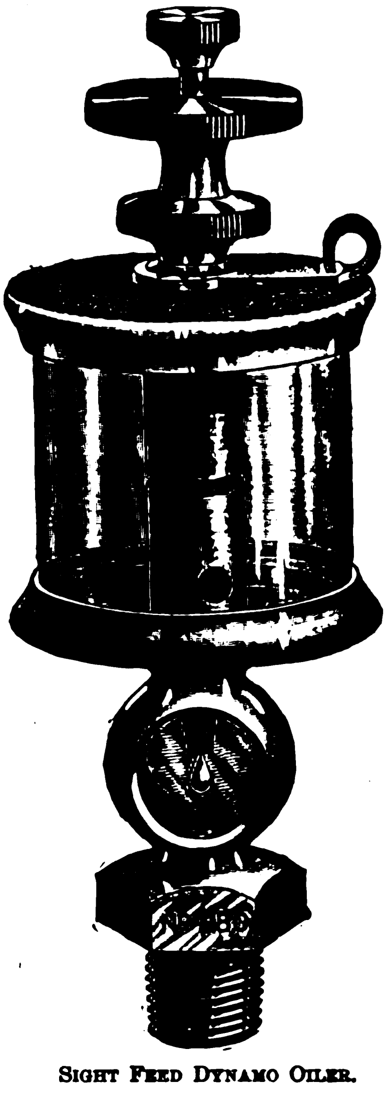
The Jewell Incandescent Lamp.

It is made with bases for all systems and of all the required voltages and of 16 or other desired candle power, and is claimed by the makers to be a thoroughly perfected, economical, and durable lamp.

Mr. H. A. Kinney, of Omaha, Neb., where he represents as general agent the Detroit Motor Co., was a caller at the Western office of The Electrical Engineer last week. He is an energetic, wide awake business man, and is finding a good field for his work in the West.

SIGHT FEED DYNAMO OILER.

The accompanying illustration shows a sight feed dynamo oiler, recently introduced by the Michigan Lubricator Co., of Detroit, Mich. It is made of heavy and finely finished bronze castings, and the regulation is effected by the main valve stem, which is secured from fluctuation by means of a jam nut.



Sight Feed Dynamo Oiler.

By operating the auxiliary or "quick-stop" valve at the top of the main valve stem, the feed can be instantly shut off or renewed to its original flow without delay. Shanks are furnished in four styles, with two holes open, two holes protected by lenses, four holes open, and four holes protected by a tube. These oilers have become very popular, both in this country and abroad.

CARHART-CLARK STANDARD CELLS.

Considerable attention has recently been given by electricians to the subject of "Standard Cells," as such an instrument is indispensable for use in calibrating voltmeters and in all cases when an absolute standard of E. M. F. is necessary. The regular Clark cell did not prove satisfactory, as it cannot be carried about and must be set up in the place where used. To overcome this serious defect, Prof. H. S. Carhart, of the University of Michigan, devoted a large amount of time to the subject, and about two years ago brought out the Carhart-Clark standard cell which has been exclusively used with most excellent results. By a special process, Prof. Carhart makes these cells so that they can be carried in the pocket or sent from place to place without any deterioration, so that they are perfectly portable. Another remarkable feature of this cell is its very low temperature coefficient, which has been reduced to .00038, this making, for all practicable purposes, the the temperature change inappreciable. Every cell is accompanied by Prof. Carhart's certificate, and they are placed on the market exclusively by Queen & Co., of Philadelphia.

A NOVEL BURGLAR ALARM SYSTEM.

Among those who have at various times turned their attention to burglar alarms is Mr. O. W. Hart, of Fall River, Mass., who has recently perfected a system of this kind, possessing a number of novel features.

In this system, after the alarm is set for the night, the person who locks up the premises presses a button on the side of the door, which, in turn, operates a drop that closes the necessary circuits for putting the alarm in working order for the night.

After this has been done, no one can enter the building, even if the wires leading to the door and window springs are in full sight. There is also a silent alarm connected to the police station, but should this circuit become broken or cut, an audible alarm on the outside of the building is instantly put in circuit; thus the building is never without protection. The audible alarm consists of a fifteen-inch mechanical gong giving 400 strokes; this gong is also an invention of Mr. Hart, and is arranged so that the alarm will ring if tampered with from the outside. All alarms are rung by an open circuit battery, and even if the closed circuit battery should "open", or become weak, the alarm will still be in operation.

Should any short circuit occur on the line, no false signal is given, but a small alarm bell is rung, giving a signal of the fact. Should this occur in the night, the main signal can be given, even with the short circuit on the line. The battery and instruments are protected and cannot be tampered with in any case.

There is a clock attached to this system which switches the current off the line at a given time and opens the circuit at any hour desired. This clock is much like the bank safe time lock now in use.

The cost of running the system is about 25 cents a month.

THE MAINE ELECTRICAL IMPROVEMENT CO.

The above company have secured the contract for the reconstruction of the power plant of the Brunswick Electric Light & Power Company, at Brunswick, Me. This plant is located on an island in the Androscoggin River. This island is a part of a rock formation in the bed of the river, forming one of the most beautiful cascades to be found upon the river, which is noted for its many waterfalls. Owing to the abundance of water power available and the advantageous position of this power plant, an unlimited amount of power can be secured for the uses of the many enterprises for which Brunswick is fast becoming prominent, and that, too, at a nominal cost. The variation in water level of the Androscoggin River during the different seasons of the year is nominal, and therefore the power secured therefrom is practically constant for all seasons of the year.

In a place such as Brunswick, located as it is within a stone's throw of "Casco Bay," which is one of the finest summer resorts upon the Atlantic coast, convenient to Portland, Bath, and others of the principal points in Maine, this electrical enterprise cannot but be a success, and the Maine Electrical Improvement Co. are indeed fortunate in securing so valuable a contract, embracing as it does a combination of electrical, mechanical, and hydraulic engineering.

THE BALL ENGINE CO.

The Ball Engine Co., of Erie, Pa., have the following letter from the Jeffrey Mf'g. Co. of Columbus, O.: "We have two of your 13"x12" automatic engines at the Helvetia mines, Helvetia, Clearfield Co., Pa. These engines are running two of our 80 horse power dynamos, generating power for transmission into the mines for the purpose of running our Jeffrey electric coal mining machines. The duty these engines are called upon to perform is very severe; perhaps more so than street railway work, for the reason that the load is thrown off and on by the short run of each engine and consequent sudden stop. We require a regulation for our work that shall not exceed a loss in revolutions of 2 per cent. The Ball engines at the above mines have been running about four weeks, and are giving entire satisfaction. They are noticed for their beautiful and solid construction, and the quietness and steadiness with which they run."

D. M. STEWARD MANUFACTURING CO.

The D. M. Steward Manufacturing Co., of Chattanooga, Tenn., write us: "We are pleased to report that the lava insulators are in demand to that extent that we are pushed to keep our customers anywhere nearly supplied. We ship goods to all parts of this continent and have to refuse orders for many shapes which we are not prepared to make. We are getting a great many letters from new customers, who credit THE ELECTRICAL ENGINEER with putting them in communication with us."

THE "WING" FANS AND PLANTS.

L. J. Wing & Co., 126 Liberty street, N. Y., write as follows:—

Trade has been good, especially in the East. We have added isolated lighting by electricity, through the use of small gas or steam engines, for private residences, stores, small hotels, etc.

The later developments in this class of machinery have made this system of lighting more economical than burning gas, while at the same time giving the comfort, beauty and safety of the electric light.

Among our sales for the past month we note: Jefferson Mfg. Co., Jefferson, Mass.; W. T. Henry & Co., Philadelphia, Pa.; John Simmons, New York, N. Y.; Manhattan Print Works, New York, N. Y.; Am. Carpet Cleaning Works, Brooklyn, N. Y.; U. S. Heating and Plumbing Co., Boston, Mass.; Judge Building, New York, N. Y.; Edison General Electric Co., New York, N. Y.; W. & J. Agate, Pittsford, N. Y.; Old Kentucky Cotton Mills, Louisville, Ky.; Russell & Morgan Co., Cincinnati, Ohio; Chelsea Jute Mills, Brooklyn, N. Y.; Ballard Vale Woolen Co., Ballard Vale, Mass.; W. H. Tolhurst & Son, Troy, N. Y.; Louisville Cotton Mills, Louisville, Ky.; Coombs, Crosby & Eddy, New York, N. Y.

THE AMERICAN ELECTRIC ELEVATOR CO.

The American Electric Elevator Co., of this city, have recently put in operation an electric elevator in the Grimes Building, Kansas City, which runs at a speed of 250 feet per minute, carrying an average load of 1,200 pounds with nine horse-power. This elevator is giving great satisfaction, and runs more smoothly and quietly than the average hydraulic elevator, and nearly equal to the very best hydraulic.

They are now installing a number of their elevators in various parts of the country, from Minnesota to Texas, and are at present installing an elevator in the Duquesne Traction Co.'s car house at Pittsburgh, Pa., for the purpose of raising the cars, a load of 10,000 pounds, from the tracks on the first floor to the paint shop on the floor above. This elevator is expected to be in operation in a few days, and will probably be the largest electric elevator at present in existence.

THE MONTREAL CONVENTION.

The provisional committee for the reception of the National Electric Light Association on their approaching visit to Montreal met on May 23, at the Windsor, in that city. The Governor-General has expressed the hope that he may be able to be present on the occasion if the visit takes place in September, and has announced that under any circumstances he will be glad to give his patronage to the meeting. It begins to be evident that the meeting will be a great success. President Huntley visited New York last week to confer with Secretary Beane about the various arrangements necessary.

NEW ENGLAND TRADE NOTES.

THE TROPICAL AMERICAN TELEPHONE CO., owner of the "Hynes" annunciator drop patent(No. 425,078), has begun suit in the U. S. District court in New York city against the Western Electric Co. and Irving Loveridge, its agent, for infringement of said patent by making and selling the "Hynes" annunciator drops used in switch-boards. Purchasers for home use or for export should buy these drops of the Tropical American Telephone Co. and avoid legal liability, as no other manufacturer has any authority to make or sell them. This drop is also known as the "Williams" drop.

THE REDDING ELECTRIC CO. have removed their executive and sales offices from 48 Hanover street to 41 Federal street, Boston, where all business will be transacted under the supervision of Mr. H. M. Nichols, secretary of the company. In their new premises they will have much more room to handle their rapidly increasing business, and be better able to handle promptly the demands of their customers. Large orders are already being received for Star Electrix goods and other specialties.

THE EVANS FRICTION CONE CO. have recently been turning their attention to the supply of their cones for producing variable speeds, which are peculiarly adaptable for wire mills, testing rooms, laboratory work, etc. Amongst their recent sales they have furnished goods to the following well-known companies: Taunton Copper Manufacturing Co., Taunton, Mass.; W. B. Tucker, Elizabeth, N. J.; Murray, Whitehead & Murray, Trenton, N. J.; Maschinen Fabrik Oerlikon, Zurich, Switzerland; Thomson Electric Welding Co., Lynn, Mass.; Thomson-Houston Electric Co., Lynn, Mass.; Electric Pipe Bending Co., Harrison, N. J.; Edison Electric Manufacturing Co., Schenectady, N. Y.; The Okonite Co., Passaic, N. J; Sawyer-Man Electric Co., New York; Washburn & Moen Manufacturing Co., Worcester, Mass.

THE BURTON ELECTRIC HEATER IN PRACTICAL WORK.

A RAILROAD COMMISSIONER in discussing methods of heating railway cars, recently said that electricity was as yet too dear to enter into the question. Similar opinion was expressed by a well-known electrician some weeks ago in regard to domestic heating. If in one field the mechanical appliances necessary are not yet so perfected as to admit of its adoption, and in the other the cost of current may be too great, yet for the heating of electric cars it has been thoroughly established that electricity is not only an agent theoretically perfect, but one whose use is economically practicable.

This has been demonstrated beyond the possibility of a doubt, by the application on electric roads of the Burton electric heater, the invention of Dr. W. Leigh Burton, of Richmond, Va. The history of this invention, in some respects remarkable, chronicles some marked triumphs, not unhampered, it is true, by the usual suspicion with which a new departure is regarded. For some years Dr. Burton had devoted much attention to electrical science and had carried on a long series of experiments with electric heaters. Beginning with the well-known fact that the heat generated in a conductor is proportional to the resistance of such conductor and the strength of current used, the problem was to devise some arrangement whereby the wires, when given current such as would heat them to a requisite intensity, would yet be in no danger of fusion. After much experiment, it was discovered that platinum or any wire of refractory material, even when of considerable length, if surrounded by finely powdered fire clay or similar substance, will, without danger of fusing, carry an electric current of such strength as would instantly destroy it if not thus surrounded. In this way the entire surface of the wire might be covered by a material which, although able to communicate the heat to the surrounding atmosphere, is of such high electrical resistance that it will not carry off a sufficiently large portion of the current to prevent its efficient action as a heat producer.

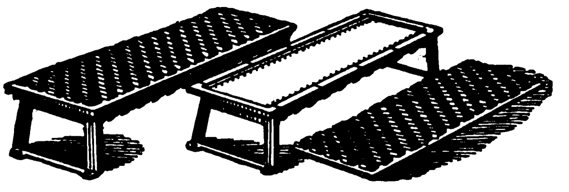


FIG. 1.

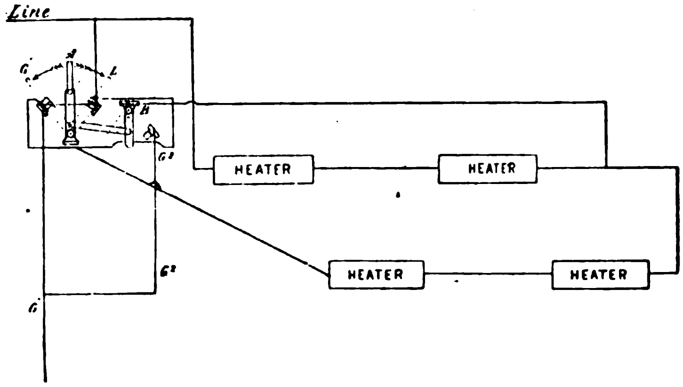


FIG. 4.

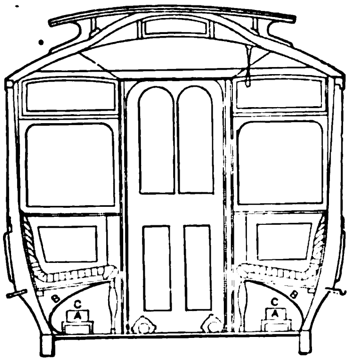
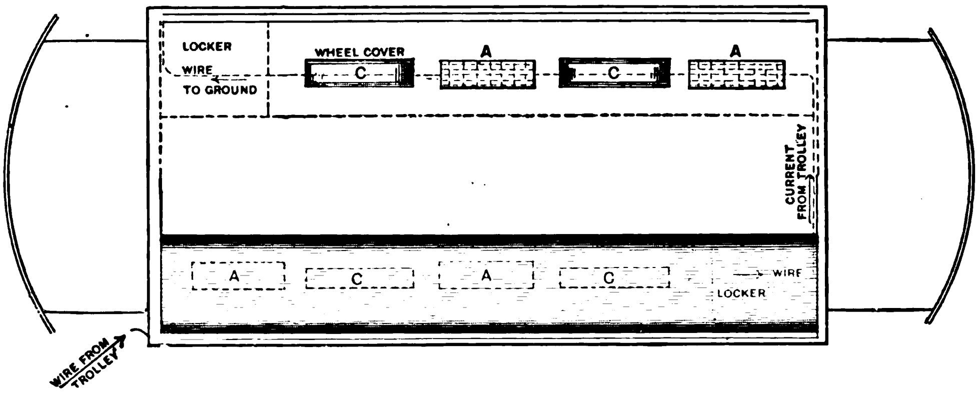


FIG. 2.



THE BURTON HEATER.

FIG 3.

A patent was granted to Dr. Burton upon the practical application of his invention in 1887, and some time later he secured another patent on an improved method of electrically connecting the heaters. Up to the present time, however, its use has been confined to electric cars. The apparatus used in street car work, and the method of wiring, will be readily understood by reference to the accompanying diagrams.

Fig. 1 shows the iron casing with a corrugated covering to facilitate the radiation of the heat, which contains the German silver wire stretched back and forth across the case and embedded in the fire clay. In wiring the ordinary street car, two such heaters are usually placed on each side under the seats, as shown in Figs. 2 and 3. The wiring is very easily done. Connection is made to the trolley wire in one corner of the car, and the current conveyed through the heaters under one seat and carried to the other side to a ground connection on the truck. The method of wiring adopted by the company is shown in Fig. 4, and for street car service the electrical resistance of the heaters is so adjusted that on a 450 volt circuit they use three amperes of current. When, therefore, the handle of the switch A is turned on L, a shunt from the line connection, and B closed, the heaters are thrown in series of two for a short time only, causing the use of six amperes of current in each set. When a sufficiently high temperature has been attained in these, which will be in fifteen or twenty minutes, the handle A is turned on G, ground connection, and B opened. This causes them to be thrown in series of four, when the heat will be maintained in them for a long time without being appreciably lowered, with the use of only three amperes of current.

The process of warming the cars is supposed to take place in the morning before the car leaves the shed, when there is no other use for the current. The normal use of the current, however, being only three amperes, the cost should be calculated on that basis.

As far as regards expense, it has been proved to the satisfaction of the officials on a number of roads, that it is fully as economical, and even more so when service and contingent expenses are considered, as the ordinary coal stove. Lieut. S. Dana Greene, the well-known electrician, who is consulting electrician for the Burton Company, estimates the cost to amount to less than 10 cents per day for each car, and in some cases, this estimate has been found too great.

The company are constantly in receipt of testimonials from various roads speaking of the heater in the highest terms as regards safety, comfort and economy. The patrons of the road using the heater are even more enthusiastic than the officials, and to any one familiar, by sad experience, with the dirty and gaseous condition of the average coal heated car, the absolute cleanliness and absence of odors, together with the even temperature of a car electrically heated, is a revelation in modern car heating.

The electric heater would find its warmest welcome, however, as a successor to that "deadly car stove" to whose account so many tragedies must be placed. Here the absolute safety of the electric heater should commend it, even though dividends were lessened somewhat by its use. By the employment of dynamos and storage batteries now carried on trains for incandescent lighting, the heater could be used, and the increased safety and comfort would more than compensate for any expense involved.

Other uses for the heater are innumerable and suggest themselves at once. With its almost ideal qualifications, its general application is warmly urged by those familiar with its operation, and, when once before the public, there can be no doubt of its rapid sale.

The John Scott legacy medal has been awarded the inventors for this electric heater on the recommendation of the Franklin Institute, of Philadelphia. The heaters are manufactured by the Burton Electric Company, Richmond, Va., for whom the Electric Merchandise Company, of Chicago, are selling agents.

A MAMMOTH MUNSON BELT.

At the invitation of the Charles Munson Belting Co., of Chicago, a party of gentlemen, among whom were some of the representatives of the technical and daily press, visited their factory to inspect a new belt of generous proportions which they are manufacturing for the Missouri Electric Street Railway Co., of St. Louis.

This enormous belt is no less than 72" in width, being one of the largest in the world. It is made of the very finest picked stock, and is of double leather 150' long, and capable of transmitting easily 2,000 h. p. Colonel J. H. Shay and Mr. Groetzinger, secretary of the company, explained the beauties of their pet, the excellence of the material, the fine finish in manufacture of the belt calling forth much commendation. It will belt direct from the engine to the line shaft in the station, which is equipped with the famous Hill clutch pulleys. All of the shafting work, which is of the very highest class of work, has been installed by the Hill Clutch Works, of Cleveland.

The Munson Belting Co. have already furnished two 54" double leather belts for the same plant, 140' each in length, and 860' of 16" belting, which is used for driving the generators. With the order for the monster belt was included a further order for two generator belts, 84" wide and each 74' long. All these belts are noticeable for the excellence of the workmanship, and their immense strength and durability.

NEW YORK NOTES.

Mr. W. S. Turner, of the Woodbridge & Turner Engineering Co., has married Miss Helen Sewall, of Clarinda, Ia.

Mr. T. J. Murphy, of 96 Columbus ave., this city, is in direct connection with one of the finest slate quarries in the country, and furnishes slate for all electrical purposes, such as switchboards, switches, fusible cut-outs, resistance boards, etc. As an evidence of the work which he does, mention might be made of a large order which he recently executed for a New York concern. The slate was in pieces of 22 square feet, 5-8 inch thick, each piece pierced with 12,000 holes, ¼ inch and ¼ inch apart. He sends without charge by express a sample of finished and unfinished slate, and invites a chance to quote on quantities of any goods in his line.

Mr. E. Gabel, formerly with the Munson Belting Co., will respresent the Page Belting Co. hereafter in this city.

Walton E. Crane, manufacturer of the popular "Common Sense" oil filter, of Minneapolis, Minn., has removed to New York, and is located at Nos. 9 and 11 West 13th street. His filter business has been growing so fast that it has become necessary to have an Eastern office and shipping point for the Eastern trade, and also to accommodate his rapidly growing export trade. The "C. S." oil filters seem to introduce themselves, wherever electric plants are established, and that means nearly all over the world. The reversed gravity, submerged filtering material, and visible operation of this filter have secured for it the warmest admiration and praise from its purchasers and users.

E. G. Bernard & Co., electricians, etc., of Troy, N. Y., have received the contract for electrical supplies for the house of Hon. Levi P. Morton, at Rheinbeck, N. Y.

PHILADELPHIA NOTES.

The Equitable Engineering & Construction Co. have secured the contract for the construction of the Lebanon & Annville Electric Railway, Lebanon, Pa. Mr. S. Ashton Hand has been elected vice-president and mechanical engineer. Mr. L. K. Perat, formerly of the Thomson-Houston Co., Lynn, has joined the force of the Equitable Engneering Co.

The Heisler Electric Light Co., of this city, have just installed plants of their Long Distance Series Incandescent Lighting at the following cities: Montgomery, Ala.; Colorado, Texas; Montpelier, Vt.; Saltillo, Mexico; Norwalk, Ohio, and Port Richmond, S. I. They have received orders for their new series lamps for use on arc light circuits, which will require over three months to fill.

Baltimore, Md.—Messrs Kingsbury & Mustand have the contract to equip the New National Theatre, at Washington, D. C., with 650 incandescent lights of the Edison three-wire system.

Mr. Henry A. Reed, of the Bishop Gutta Percha Co., New York, was in this city last week and contracted with the West End Electric Co. to furnish all the cables used in their large plant now under construction.

Norwalk, Ohio.—The Howe Construction Co. are increasing their plant with 700 32 c. p. lamps of the Heisler system.

WESTERN TRADE NOTES.

Mr. W. L. Adams, who has been associated with the Northern Engineering Co., of Buffalo, has joined the forces of the Electric Merchandise Co., of Chicago. Mr. Adams is a thoroughly practical man, and has a large acquaintance among street railway men. He will represent the company chiefly in the East, where he will look after their rapidly growing business, and introduce to street railway men all the new and valuable specialties which they are continually producing.

Mr. D. B. Dean, traveling representative of the Electric Merchandise Co., has just returned from a highly successful trip, and will leave in a few days for the Pacific coast in the interests of his company.

The Electric Merchandise Co., through their energetic representative, Mr. D. B. Dean, have recently closed a contract with the Williamsport Passenger Railway Co., of Williamsport, Pa., for all their necessary line material and supplies, for the equipment of six miles of road.

Mr. Henry C. Eddy, who recently resigned his position as Western manager of the *Electrical World*, has associated himself with the *Street Railway Journal*, and will look after the interests of our esteemed contemporary in the West.

The National Construction Co., 119 to 121 La Salle street, are going to build a new electric light plant on Dearborn street. The work is in the hands of Mr W. L. Abbott, manager of the above named company, and under his supervision, and will be one of the most complete plants in the country.

The Illinois Electric Material Co. are having a fine run on their general electrical supplies and the various specialties they handle, and are doing a prosperous and growing business.

Mr. Charles E. Brown, the traveling representative of the Central Electric Co., has returned from a Western trip, the results of which have been exceedingly satisfactory in the shape of numerous orders for their valuable supplies and specialties of all kinds.

Mr. Jas. H. McGraw, president of the *Street Railway Journal*, has been spending some days in Chicago and was a caller at the Western office of The Electrical Engineer last week.

Mr. S. W. Trawick, of the St. Louis office, of the Westinghouse Electric Mfg. Co., was in town last week.

The new restaurant service of the Chicago Electric Club was most successfully inaugurated last week with a very elegant table d' hote lunch, and everything is now in fine running order. The simplest lunch to the most elaborate dinner can be obtained at the club. These desirable results have been obtained by the indefatigable efforts of Mr. W. B. Pearson, chairman of the Board of Managers, assisted by his able lieutenant, Mr. W. P. Sullivan, the manager of the club, and the united thanks of the electrical fraternity are due to Mr. Pearson for the able manner in which he has handled things, and devoted so large a portion of his time for some while past to the work.

Thwing Electric Co.—The sale of the property of the Thwing Electric Co., Lake and Peoria streets, Chicago, has been postponed till June 8th, and the prospect is very fair indeed that the business of the company, which is the manufacture of a perfected incandescent lamp, will either be carried on by a reorganization, comprising some of the old officers, or by new parties.

Mr. Frank McMaster, who has been associated for some time past with the Chicago Edison Co., has accepted a position as electrician of the Chicago Electric Motor Company, who are manufacturing large numbers of motors of all sizes, for fan purposes and all kinds of electrical work. Mr. McMaster will assist Mr. B. D. Southard, manager of the above mentioned company, in designing the machines, paying special attention to the electrical part of them, Mr. Southard, who is a well known mechanical engineer, looking after the mechanical design. Mr. McMaster is an energetic, well posted electrician, and his experience in this line will be of material service to the company.

Mr. H. M. Underwood, the energetic western agent of The Interior Conduit & Insulation Co., is rapidly introducing their well-known and valuable system in the West. He has already secured some large contracts, and has a number of important deals on hand.

Paiste. A large consignment of the well and favorably known Paiste specialties, has been received at the Western office of H. T. Paiste, 341 The Rookery, which is in charge of Mr. Thomas G. Grier, the well-known mechanical and electrical engineer.

Mr. Fred Calkins, of F. W. Calkins & Son, has just sold a 1,000 light incandescent machine of the Mayo system.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XI. JUNE 10, 1891. No. 162.

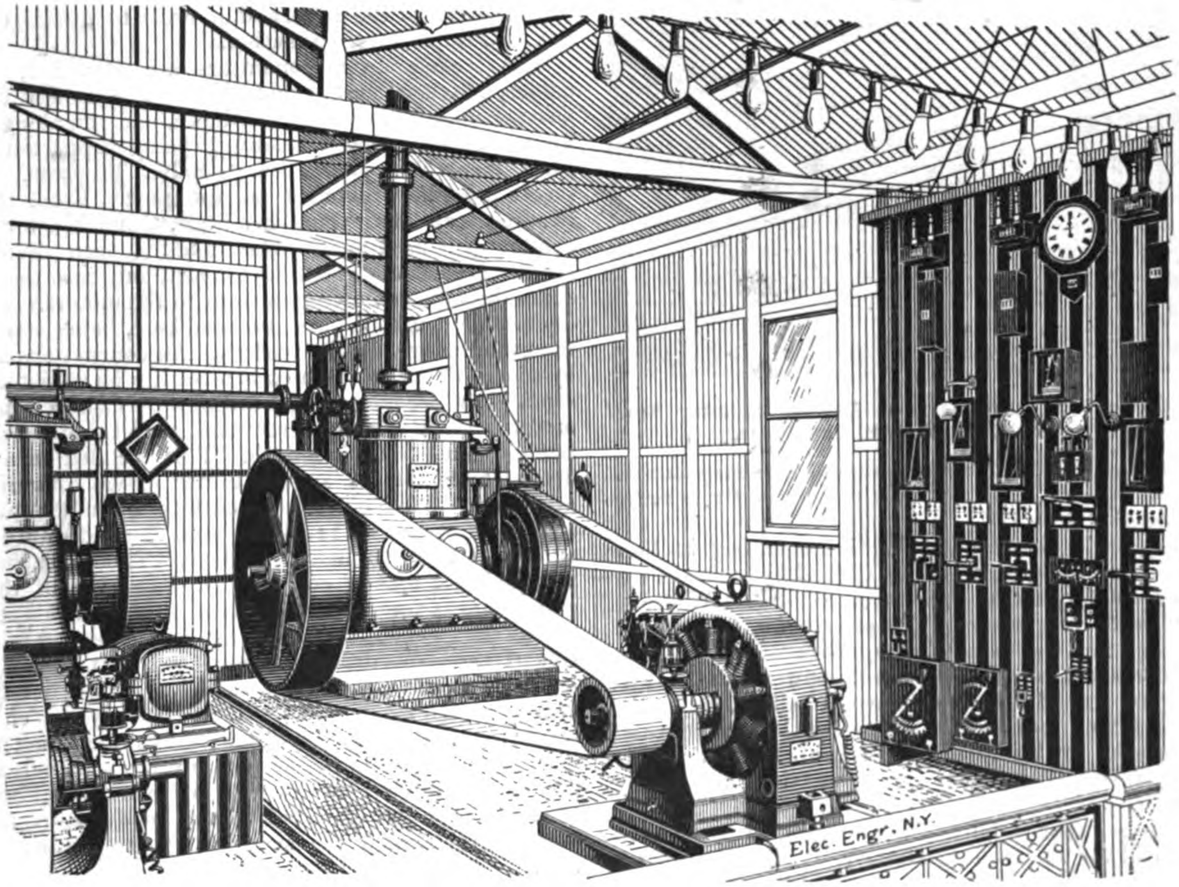
ELECTRIC LIGHT IN AUSTRALIA.

BY

Arthur C. Lovett.

AS a regular reader of THE ELECTRICAL ENGINEER, it has occurred to me that a few items in connection with lighting in Australia may be of interest to your readers.

We have three towns lit by Thomson-Houston plants, namely, Young, Lambton, and Penrith, and one on the Westinghouse system. The installations are all comparatively small, but it is a start in the right direction.



Elec. Engr. N.Y.

FIG. 1.—ELECTRIC LIGHT STATION, WESTINGHOUSE SYSTEM, NEWCASTLE, NEW SOUTH WALES, AUSTRALIA.

The installation at Newcastle, which is the first Westinghouse plant installed in Australia, was opened early in January last, and is shown in the accompanying engraving, Fig. 1. There are two 750 light 1,000 volt alternating current dynamos with separate exciters, both dynamos and exciters being driven direct from the engines. The engines, of which there are two, are of the well-known Westinghouse type, indicating 75 h. p., supplied with steam at 120 lbs. pressure from two Babcock & Wilcox boilers.

In addition to these, which are for the incandescent circuits, there is a Brush arc light dynamo driven by a smaller Westinghouse engine of about 25 h. p. The usual Westinghouse street system is used for the street circuits, the incandescent lamps, which are 50 volt, being run in multiple arc in groups of 20 in series. There are at present 400 incandescent lamps on the street circuits.

In Hunter street, the principal thoroughfare, there are 23 Brockie-Pell arc lamps suspended by cross wires in the centre of the street as shown in Fig. 2.

The cables, which are Callender's throughout, are all overhead. There has been a good deal of friction with the authorities of the telegraph department as to the rather haphazard way in which they cross the telegraph wires without any guard wires.

The switchboard is a very handsome one and is mounted on colonial woods. On the switchboard there is a novelty to us in Australia in the shape of cut-outs having a platinum wire indicator.

The work was carried out for the contractors, Messrs. Westcott, Marshall & Adams, by Mr. E. J. Erskine, under the supervision of Mr. G. Hitchcock, of the Westinghouse company.

Additional interest is added to this installation by the fact that so close to it, at Lambton, which is a suburb of Newcastle, we have a Thomson-Houston plant, which has been in operation since September 10, 1890.

There two 650 light Thomson-Houston alternating current dynamos driven by two Fowler's engines of 65 h. p. each. There are two locomotive boilers supplying steam at 140 lbs. pressure. The street circuits are four in number, each circuit consisting of forty 25 candle power 25 volt lamps run in series.

The house circuits at present only take up about 400 lights, but the demand is rapidly increasing.

The contractors were Messrs. H. H. Kingsbury & Co., the agents for the Thomson-Houston Co. Messrs. Kingsbury have installed almost identical plants at Penrith and Young. The Young installation has been running since March, 1889. The installation at Penrith was opened in August, 1890. I may state that the population of Young is only 2,300 and that of Penrith 3,000; Lambton, the installation of which was opened on September 10, 1890, has 6,000 and Newcastle, 14,000 inhabitants. We have but one electric street railway in New South Wales, and that is a short length of about one mile and a quarter beteen Randwick and Waverley, two of the Sydney suburbs. It is on the Thomson-Houston overhead system, and was erected for the Government by Messrs. Kingsbury & Co. The line is a very stiff one having a lot of steep gradients on sharp curves. There are three cars fitted up, of which one only is being used at present.

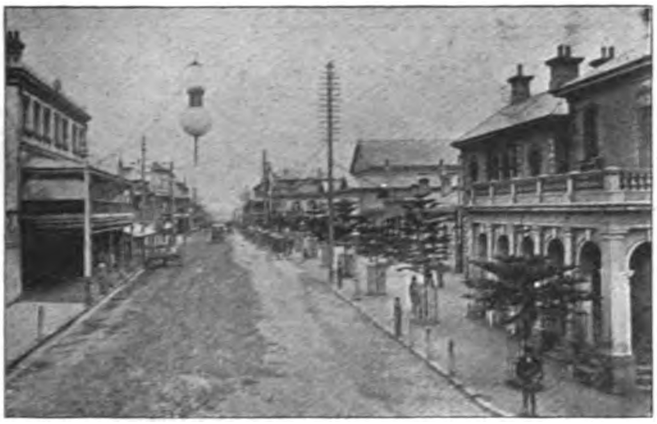


FIG. 2.—BROCKIE-PELL ARC LAMPS ON HUNTER STREET, NEWCASTLE, NEW SOUTH WALES, AUSTRALIA.

In Sydney itself, electric lighting is beginning to look up. The contract for the lighting of Redfern, one of the suburbs nearest the city has been awarded to the Williamson Electrical & Engineering Company, who, I hear, are contemplating putting in a Westinghouse plant. There are to be 400 street lamps of 25 candle power each. The price tendered was £10,326 exclusive of poles, which the corporation intend putting in themselves. The contract has also been let for Beewood, another suburb of Sydney, to Messrs. Wood Bros., who intend putting in Mordey alternators.

Half-a-dozen other suburbs have combined and have decided to call for tenders immediately. The city fathers themselves have also been considering the matter for some time, and have practically decided to form a small committee of experts to advise them in the matter.

A good many of the country towns, fired by the energy evinced at Young, Lambton, etc., are all eagerly going into the pros and cons of the question. Goulburn, Albury, Grafton, Glen Innes, Maitland, and others too numerous to mention, are all deeply involved in considering volts, ohms and amperes.

ELECTRICAL HANDLING OF PLATE GLASS.

An interesting application of electric power has been made at the Pittsburgh Glass Works, at Ford City, Pa., where a motor is used for hauling the polishing tables about the factory. The operation of the motor is said to be very satisfactory. The table with glass in place weighs 15 tons. It is expected that this initial plant will be followed up by a number of others.

ELECTRIC MINING AT BROWNSVILLE, PA.

BY ALFRED E. BRADDELL.

As a means of saving labor and time, electricity is now rapidly coming to the fore to replace, in a great measure, the pick and shovel in coal mines. A plant has recently been installed in the mines operated by the Redstone Oil, Coal and Coke Co., situated near Brownsville, Pa. The plant consists of a United States generator (80 h. p.) 250 volts, driven by a 200 h. p. engine made by C. C. Cooper, Mt. Vernon, Ohio, with two boilers manufactured by the Altoona Mfg. Co., of Altoona, Pa.

The generator is not driven direct from the engine but from counter-shafting. The fly wheel of the engine is 142½ inches in diameter, which is belted to a pulley of 42 inches diameter, placed on one end of the counter-shaft. On the other end of this is a pulley 60 inches diameter, which in turn is belted to a 30 inch pulley on the generator. The motors were manufactured by the Jeffrey Mfg. Co., of Columbus, Ohio, there being two in operation at the present time. These motors are of very solid construction in order to withstand the rough usage applied to them by the miners, as they have necessarily to be shifted about to the various parts of the mine, and, in order to do this, crowbars, etc., are called into requisition.

The feeders from generators are stranded, insulated cables, No. 0000 B. S. each. These are brought down the shaft, which is 280 feet in depth, and run along what is known as the "main heading," being supported on large glass insulators placed on wooden brackets, the opposite poles kept about 8 inches apart. From this main heading run the "butt headings," and No. 0 B. S. bare conductor is used here. The mine is then divided into rooms placed about 33 feet apart, and into these rooms come the taps conveying current to the motors. Bare conductors (No. 2 B. S.) are also used here, being supported in the same manner as the feeders. All connections are made by means of clamps, which can readily be adjusted, at the same time securing a good contact. Connection to the motor is made through a stranded twin cable heavily insulated, about 100 ft. in length. This is coiled on a reel or drum which rotates as the motor moves forward during operation. This operation consists of under-cutting the coal by a series of revolving teeth for a distance of 6 ft. and about 18 to 20 inches in width. This is calculated to be equal to 4 tons of coal, and on timing one of these machines it was found to have taken exactly 4 minutes to do the work. When the machine has under-cut along one side of the room the coal is blasted so that it can then be easily removed with the shovel. Three men are in charge of the machine, and it is certainly an engrossing sight to watch these unskilled toilers handling, with the greatest of ease and the utmost indifference, such a powerful, yet unseen, force. It was, in truth, a verification of the saying: "You push the button, we do the rest." These men simply turned the switch and the current did the rest.

ELECTRICITY APPLIED TO ORGANS.

Mr. Hope Jones, of Liverpool, who has already built and used an electric organ, stated to the College of Organists, the other day, that he was confident that he could construct an organ without bellows, sound boards, or even pipes, the sound being produced by electricity. Stop-knobs he has already abolished, a touch of an electric knob instantly putting the stop in or out of operation. He has also devised a "transposing switch," by which the music as it is being played can instantly be transposed to any higher or lower key by the action of electricity.

DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.

BY

Robert P. Dobbie

THE prominence that the rapid transit question now occupies in the public mind, renders anything bearing on its achievement of special interest. The needs of the times are fast making the horse car a thing of the past, and even the higher speed of the electric street car falls far short of the actual requirements of to-day.

The impracticability of gears for anything like high speed—for instance, from 30 to 60 miles per hour—and the certainty that, if the armature were placed on the axle direct, the vibration would insure disaster to any known insulation, caused the writer to devise a means by which all the advantages of direct connection could be gained, and at the same time retain the well-known action of springs to obviate or suppress vibration.

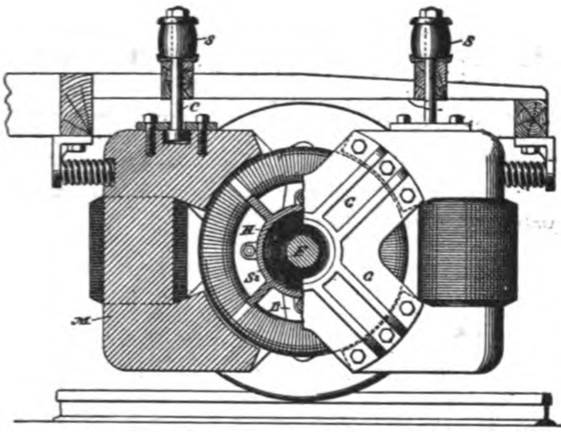


FIG. 1.—DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.

My ideas as to how this should be done have been embodied in an arrangement, shown in Figs. 1 and 2, in which the desirable combination of spring suspension and direct coupling are attained by the use of a sleeve H concentric with the axle F. Upon this the motor is mounted,—the armature by the usual spider or other device, and the field magnets by bearings G. At the ends of this sleeve are cranks and crank pins which are coupled to a crank pin of similar radius (in relation to the centre of axle), by a link L, which assumes a position parallel to the tangent of the armature or wheel periphery. Between the axle and sleeve are interposed rubber or other springs or cushions, to prevent the possibility of the axle striking the sleeve by a severe jolt caused by faults in the track.

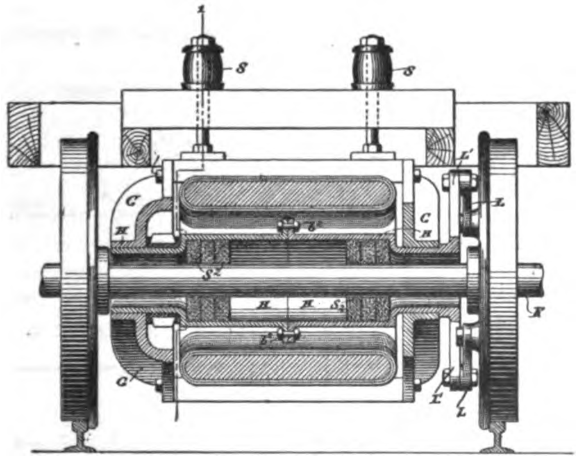


FIG. 2.—DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.

This whole system of armature, field magnet, and sleeve, is supported by springs s s, so that there is no weight placed upon the springs or cushions s' under normal conditions, but in construction of small motors, as shown in Fig. 3, all other supporting springs could be dispensed with, reliance being placed on the rubber springs entirely. In this case, however; cross-tie rods D' should be used to counteract the tendency of the field magnets to rotate in a direction opposite to that of the armature. Lateral motion is taken up by springs between sleeve and wheel mounted on the frame so as to act when a lateral strain occurs, as, for instance, in going around a curve. Having thus described the principles, it would be interesting to give an outline of the weight, speed and power by an example.

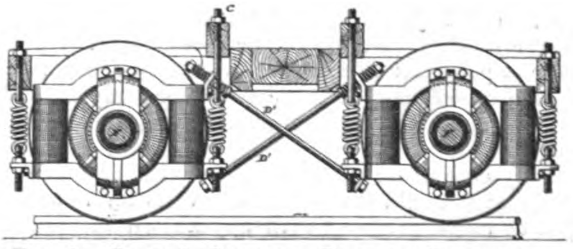


FIG. 3.—DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.

Referring to Figs. 1 and 2, these show one motor and a pair of wheels 42 inches in diam.; the armature is 30 inches long by 30 inches in diam.; this being about the largest possible with this size of wheel, and a 4′ 8½″ gauge. This is placed in a four-pole field specially designed with reference to the clearance of the roadway and protection of coils, and connected by bronze castings G.

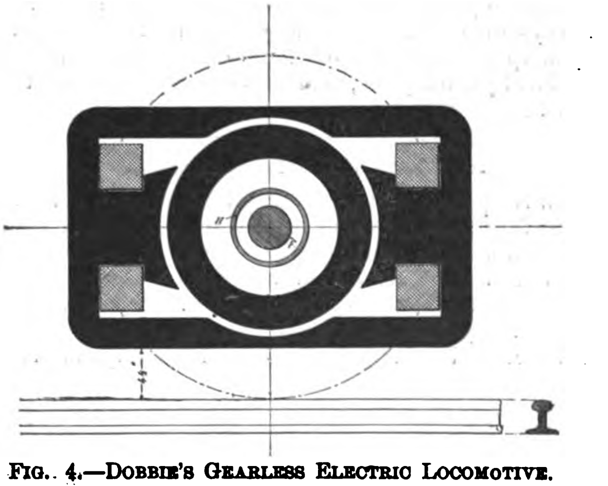


FIG. 4.—DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.

Fig. 4 shows another design that has many recommendations. It is of the so-called Kennedy type and is drawn to scale for a 15 h. p. motor on a street car axle, designed to run at 110 rev. per min. Although its weight would be greater than a high speed motor of the usual pattern, the absence of gear wheels with their frames, etc., makes the difference less than would appear at first sight, and this disadvantage is more than made up by the absence of noise and loss in transmission.

Returning to Fig. 1, the power of this motor, running at 60 miles an hour, (which would be 480 revolutions per minute for the armature) would be 150 h. p. and this could easily be developed. The clearance between the axle and sleeve is 2 inches; the diameter of the axle 6 inches. The whole weight of motor and truck frame is approximately 14 tons (of 2,000 lbs.) and is sustained by journals F outside of the wheels. Two such motors on a truck would more than equal the performance of the present elevated railroad engines, and disposes of the many objections to steam locomotives on urban and suburban railroads, so ably pointed out by Mr. Sprague in his paper before the American Institute of Electrical Engineers. A locomotive with two such trucks, weighing about 56 tons in all, and developing 600 h. p., would take the train to Philadelphia in "limited" time.

There is in this estimate nothing in the nature of an extraordinary motor giving abnormal power for its weight, but it is just a plain statement of possibilities with good electrical engineering of the present day. Upon such a motor a potential of 2,000 volts could be used, and the insulation relied upon, as there would be complete suppression of the small and rapid vibration inseparable with high speed.

It is my conviction that no motor with armature direct upon the axle would stand even 500 volts for 10 hours running at 60 miles per hour with any known insulation that could be applied, and I believe as firmly that a motor suspended by springs, as shown, is capable of fulfilling the more exacting requirements mentioned.

STEAM AND ELECTRICAL DISCHARGE.

At the last meeting of the Royal Meteorological Society, Mr. Shelford Bidwell, M.A., F.R.S., exhibited an experiment showing the effect of an electrical discharge upon the condensation of steam. The shadow of a small jet of steam cast upon a white wall is, under ordinary conditions, of feeble intensity and of neutral tint, but if the steam is electrified the density of the shadow is at once greatly increased, and it assumes a peculiar orange-brown hue. The electrical discharge appears to promote coalescence of the exceedingly minute particles of water contained in the jet, thus forming drops large enough to obstruct the more refrangible rays of light. It is suggested that this experiment may help to explain the intense darkness, often tempered by a lurid yellow glow, which is characteristic of thunder clouds.

THE FRANKFORT EXHIBITION.

The Allgemeine Elektricitäts-Gesellschaft and the Maschinenfabrik Oerlikon have now definitely undertaken to contract for transmitting power electrically from Lauffen to Frankfort, and are bound under heavy penalties to finish the work at the latest by August 15th. There is, therefore, no longer any doubt but that this important experiment, the successful issue of which will greatly interest the scientific world, will soon be an actual fact.—*Elektrizität*, the official journal of the Exhibition, is profusely illustrated, and contains a large amount of useful information on subjects connected with electricity in general and its display at the Frankfort Exhibition.—The committee of the Exhibition have decided to reserve a special building, to be opened on June 15th, for a collection of plans, projects, and results of central station working, which they think will be useful, not only in connection with the Municipal Congress but to the general visitor.

CENTRAL STATION MANAGEMENT AND FINANCE.—VI.

BY

Horatio A. Foster

Pay Roll Department.

In most stations very little attention is given to classification in this department, but much good will come of doing so, as only in such methods can any accurate calculation of costs be made.

[Form 15.] Copyrighted 1891.

____________________ Company.

____________________ *189*

Time Card for 24 hours ending 7 o'clock, A. M., this date.

THIS CARD MUST BE IN OFFICE BEFORE 8 A. M.

Name, ____________________

Occupation, ____________________

Order Number.	Hours Regular.	Hours Extra.	Rate.	Amount.

Approved,

____________________ *Foreman.*

Blank No. 15.—Employees' Time Card.

Although not absolutely necessary for those persons employed on the usual routine work, such as firemen, dynamo oilers, storekeeper and clerks, and some few others who work on salary, every employee should be compelled to turn in a time card every day, with the time devoted to different jobs stated under the regular order number and countersigned or approved by his foreman or chief. Only in this way can disputes as to the man's pay and the cost of work be surely settled.

Any neglect of the man is sure to be made up and to cease after a few losses of pay.

[Form No. 16.] Copyrighted

PAY ROLL for week ending ____________________ *1891.*

We, the undersigned, have this __________ *day of* __________ *1891, received the amount set against our respective names in full payment to date.*

NAME.	Number	OCCUPATION	Days	Rate	Operating	Outside Construction	Inside Construction	Amount Due	Number	SIGNATURE.

Blank No. 16.—Pay Roll Receipt Blank for Employees.

Form No. 15 works well for this, and when on construction or repairs the results are easily posted in the proper order or cost book. For ordinary station work, it will be found sufficient to divide the time books and pay roll into, say, three different accounts, viz.: "Operating, pole line construction, and inside wiring." Then in entering the pay roll in the cash book, the items can be stated under their different heads and posted to the proper account. Form No. 16 has been found sufficient to fit the case. Time books of various good forms can be had of any stationery store.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—II.

BY

Chas. Steinmetz.

A preliminary magnetic test of the iron to be used, which can now be carried out easily, will give the magnetic constants of the kind of iron we have. Good magnetic conductivity of the iron must be considered as of far less importance than low hysteresis. But here, in designing transformers, a certain consideration comes in, to which, so far as I know, attention has never yet been drawn, namely, whether the transformer has to be used as a *parallel converter* in a *constant potential system*, or as a *series converter* in a *constant current circuit.*

In the constant-potential transformer, the magnetization, and therefore the iron loss, is almost constant all day, no matter whether the transformer is running light, or whether it is overloaded. Therefore, if the iron loss is not very small, it will run up during the day quite considerably, and in spite of a very high efficiency for full load, the all-day efficiency will be found low. Here the heating loss in the copper is of very much less importance, because it amounts to an appreciable quantity only for full load, and decreases proportionally to the square of the load, so that it shows up rather small, in the all-day efficiency, and a transformer of considerably smaller full-load efficiency can be far more economical in continous run than a transformer which is highly efficient only for full load. Hence, in a constant-potential transformer the iron loss ought to be lower than the full-load copper loss, which I know is not always the case.

Quite different conditions, however, are met with in a constant-current transformer, which, when not loaded, is short-circuited. Here the heating loss in the copper is almost constant, and if not very small, will decrease the all-day efficiency considerably (if the converter is in circuit all day). But the iron loss varies with the load, and amounts to an appreciable quantity only for full load, being, as supposed, about proportional to the 1.7th power of the magnetization, that is, in this case, of the load. Therefore a comparatively light loss of energy in the iron will be of less importance in a constant-current transformer.

For constant-potential transformers a rather low magnetization, of about 20,000 to 30,000 lines of magnetic force per square inch, is generally used, in practice, and even this is very likely still too high for economical all-day work with the usual frequency. In Europe, where a much lower frequency ($N = 42$ for instance, Ganz & Co.) is used, the magnetization is somewhat higher, too, and nevertheless, the percentage of iron loss smaller.

But not only is the loss of energy in the transformer, in the iron and in the copper, of importance for its efficiency, but sometimes, especially in large transformers, still more consideration is needed for devising means to carry off the heat generated in the iron and copper; for the transformer is not like the dynamo, which, revolving with high speed, produces a powerful air-blast even with a smooth armature, and thereby radiates a large amount of heat per square inch of surface. The transformer, on the contrary, is entirely at rest, compact, and of small surface in comparison with its volume, and generally enclosed in an air-tight casing, and therefore no air current can be relied upon for radiating heat. Hence a much larger radiating surface is needed per watt of heat in transformers than in dynamos.

Let us, for instance, assume the *field intensity* of the transformer treated as an example, to be as a maximum, $H = 20{,}000$ lines per square inch. Therefore the *iron cross-section* needed to carry the 200,000 lines used for producing the intended induction, is:

$$q = \frac{M}{H} = \frac{200{,}000}{20{,}000} = 10 \text{ square inches.}$$

Let the *output of the transformer*, for full load, be = 2,500 watts.

Then, the *secondary* E. M. F., being $n = 70.7$ volts effective, we get the *secondary current* = 35.35 amperes effective,
and the *secondary resistance* for full load:

$$R_1 = \frac{70.7 \text{ (volts)}}{35.35 \text{ (amperes)}} = 2 \text{ ohms.}$$

Hence the *primary current* for full load is somewhat larger than: $\frac{n_1}{n} \times 35.35 = 26.5$ amperes effective.

From this, with due consideration of the drop of potential permissible for full load, and of the carrying capacity of the transformer wires, we get the cross-section of the primary and of the secondary conductor, and therefore the *length of the magnetic circuit.*

Let $l = 12$ inches, be the average length of the magnetic iron circuit.

Where exact calculation is intended, it must be borne in mind, that the "*average length*" of a magnetic circuit is not the *arithmetical* mean, but the *harmonic* mean of the different lengths in the different parts of the cross-section, that is, the *inverse value of the mean of the inverse values* of the different lengths, or:

$$l_h = \frac{q}{\int_0^q \frac{d\,q}{l}},$$

as everywhere, where conductors of different length are joined in parallel into an electric or magnetic circuit.

This harmonic mean, however, will generally be near enough to the arithmetic mean,

$$l_a = \frac{1}{q} \int_0^q l\,d\,q, \text{ to be replaced thereby.}$$

In a small Westinghouse converter I found the difference to be only 2 per cent. in favor of the *harmonic mean*, this always being *smaller* than the *geometrical* mean and this again *smaller* than the *arithmetical* mean.

Then the whole *magnetic resistance* of the iron circuit is:

$$P = \frac{\rho\, l}{q},$$

where: ρ = the specific magnetic resistance of the iron ($\mu = \frac{1}{\rho}$, its magnetic susceptibility).

Assuming $\rho = .01$,[1]

we get: $$P = \frac{.01 \times 12}{10} = .012.$$

That means: F ampere turns produce $\frac{F}{P}$ lines of mag-

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[1] This figure, like the others, is intentionally chosen such that the secondary terms, as drop of potential, exciting current, etc., are large enough to be easily shown in the small scale of the diagram. In reality ρ will be less than .001.

netic force in this magnetic circuit. Hence, to produce the magnetic current, $M = 200{,}000$ lines,
$F = M \times P = 200{,}000 \times .012 = 2{,}400$ ampere turns M. M. F. are needed.[1]

II. Transformer Diagram.

The maximum M. M. F. in the transformer under consideration was : $F = 2{,}400$ ampere turns.

Hence the M. M. F. at the the time, t is :

$$f = F \sin 2\pi N t = 2{,}400 \sin 2\pi N t\,;^{2}$$

where $N = 133 = \frac{1}{T}$ = the number of complete periods

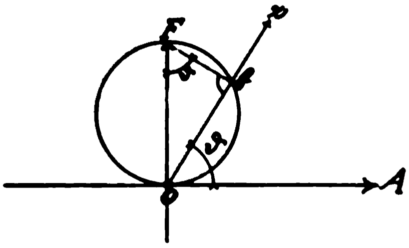

FIG. 1.

per second, and we begin to count from the time where: $f = 0$.

Let the angle, $2\pi N t = \frac{2\pi}{T} t$ be denoted by θ ;

the time $T = \frac{1}{N}$, of one complete period will therefore be represented by one revolution, or the angle, $2\pi = 360°$.

Then we can produce graphically the M. M. F. acting at any time, t, that is, at any angle, $\theta = 2\pi N t$, in a *system of polar-co-ordinates*, by assuming, in Fig. 1, a line $\overline{OA}$ as zero line, producing $\overline{OF} = F$ and perpendicular to $\overline{OA}$, and drawing a circle with $\overline{OF}$ as a diameter.

The whole revolution of a radius-vector, from the zero line $\overline{OA}$ back again to $\overline{OA}$, represents a complete period; any time, t, is represented by an angle, $AOx = \theta = 2\pi N t$, and the M. M. F. working at the time, t, that is, the angle $AOx = \theta$, is cut out on the very radius $\overline{Ox}$ of the angle θ, by its intersection with the circle with $\overline{OF}$ as a diameter, so that *this circle represents the curve of the* M. M. F. *in the polar-co-ordinate system.*

For : $\overline{Of} = \overline{OF} \sin \theta$; that is, $f = F \sin 2\pi N t$.

This representation of harmonic functions is by far more convenient than the representation in rectangular co-ordinates, by a wave line, because it shows directly the periodicity, and *represents the harmonic wave by an elementary curve, the circle.*

In the same way any other, not sinusoidal, wave can be represented by a closed unicursal curve, as we shall show further on.

As we have seen, for :

$\theta = 0$, that is, $t = 0$, the M. M. F. is : $f = 0$.

$\theta = 90°$ that is $t = \frac{T}{4} = \frac{1}{4N}$, the M. M. F. is : $f = F$.

$\theta = 180°$ that is $t = \frac{T}{2} = \frac{1}{2N}$, the M. M. F. is: $f = 0$ again.

$\theta = 270°$ that is $t = \frac{3\,T}{4} = \frac{3}{4N}$, the M. M. F. is : $f = -F$, because the circle of M. M. F. intersects the radius in its prolongation on the opposite side of o, and for $\theta = 360°$, that is, $t = T = \frac{1}{N}$, the M. M. F. is again, $f = 0$. Hence the circle, which represents the sine wave, is produced twice during each period.

In the diagrams, Figs. 1 and 2, we assumed 1 ampere turn = .0003 inch ; therefore, $\overline{OF} = 2{,}400$ ampere turns = .72 inch.

In the same way, we produce, in Fig. 2, the *secondary* E. M. F., e_1 graphically.

This is a maximum at the time at which f decreases most rapidly, that is, for $\theta = 180°$; or, $t = \frac{T}{2}$, and is then $E_1 = 100$ volts, as assumed.

Now, let 1 volt = .01 inch ; then the *secondary* E. M. F., e_1 is represented by a circle with :

$E_1 = \overline{OE_1} = 1.00$ inch in diameter.

This circle cuts out on any radius the instantaneous value of the secondary E. M. F. For instance, to the time, $t = \frac{T}{6}$, there corresponds an angle :

$$\theta = \frac{2\pi}{T} t = \frac{\pi}{3} = 60° = \text{angle } AOx,$$

and its radius $\overline{Ox}$, intersecting circle $\overline{OE_1}$ at e_1 gives at that moment the secondary E. M. F.:

$$\overline{Oe_1} = -.5 \text{ inch} = -50 \text{ volts.}$$

The M. M. F., $\overline{Of} = .623$ inch = 2,078 ampere turns.

As the maximum value for the *secondary current*, for full load, we had allowed :

$$C_1 = \frac{100\ \text{(volts)}}{2\ \text{(ohms)}} = 50 \text{ amperes.}$$

Therefore, representing 1 ampere = .03 inch, the *secondary current*, if no self-induction is present in the secondary circuit, is represented by the circle with $\overline{OC_1} = 1.5$ inch as a diameter.

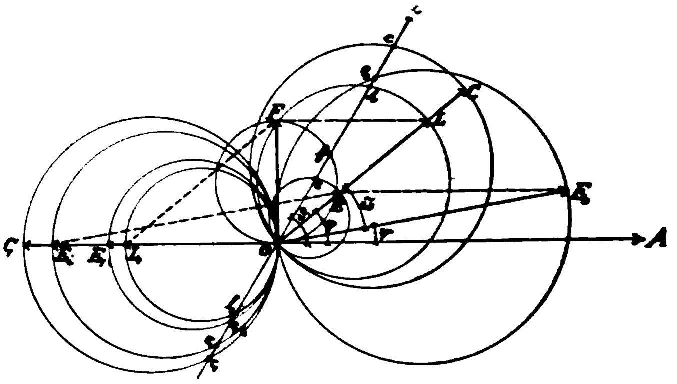

FIG. 2.

At the time, $t = \frac{T}{6}$, the secondary current is :

$$\overline{Oc_1} = -.75 \text{ inch} = -25 \text{ amperes.}$$

The M. M. F., l_1, *of the secondary current* C_1 is represented by the circle over its maximum value, $\overline{OL_1} = L_1$ as a diameter.

Now this maximum value is :

$$L_1 = n_1\, C_1 = 60 \times 50 = 3{,}000 \text{ ampere turns.}$$

1 ampere turn being chosen = .0003 inch, gives:

$$\overline{OL_1} = .9 \text{ inch.}$$

Hence, for the time, $t = \frac{T}{6}$, the instantaneous value of the secondary M. M. F. is read from the diagram to be :

$$\overline{Ol_1} = -.45 \text{ inch} = -1{,}500 \text{ ampere turns.}$$

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[1] Usually little more than 100 ampere turns in small transformers.

[2] In the following, the *instantaneous values* of the electric or magnetic quantities will always be represented by *small letters*, their *maximum values* by *capital letters*. θ is represented by its other form in the cuts.

A METHOD FOR DETERMINING TEMPERATURE-COEFFICIENTS OF GERMAN SILVER WIRES.

BY

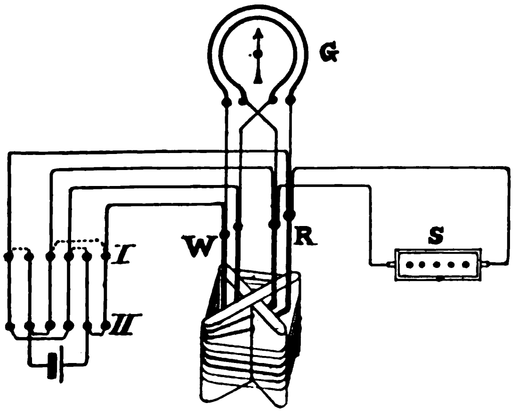
Samuel Sheldon

AND

Douglas Burnett.

CONSIDERABLE labor is required to obtain temperature-coefficients for different samples of wires for resistance coils. This could be avoided if a constant ratio between the specific conductivity and temperature-coefficient existed, as the conductivity is readily obtained. F. Kohlrausch[1] states: "It is well to mention that the temperature-coefficient can be estimated at the 10,000th part of its conductivity referred to Siemens' units." The following investigation was taken up in order to determine more definitely the ratio for German silver wires.

To obtain temperature-coefficients, a series of resistances of the wire under consideration for different temperatures is required. These were measured by the use of the "Uebergreifender Nebenschluss" (or lapped-circuit) method, the circuit for which is shown in the figure.[2]



METHOD OF DETERMINING TEMPERATURE COEFFICIENTS.

Here at W are the terminals of a standard wire, of slightly less resistance than the wire whose coefficient is to be determined. The terminals of the latter are at R. To these is shunted a rheostat, the magnitude of the resistance in which is determined by the nearness to equality of the resistances of the two wires. The equality of the currents in the two branches of the circuit, represented by the condition

$$\frac{1}{W} = \frac{1}{S} + \frac{1}{R}, \qquad (1)$$

is proved by the differential galvanometer G, the needle of which is brought to zero by adjustment of the shunt. One branch of the circuit consists of the standard wire, the other of the wire itself and its shunt.

Knowing the absolute resistance, W, of the standard, and the correct shunt resistance, S, the resistance, R, of the wire under consideration may be reduced by the formula

$$R = \frac{S\ W}{S - W} \qquad (2)$$

obtained from (1).

As the temperature of the standard and the wire changes, the shunt resistance must be changed to a large extent, compared with the change in resistance of the wire, to obtain a balance. By this means, the two resistances may be very accurately compared. Then, having a series of observations of shunt resistances, as indicated by the rheostat, of the temperatures of the rheostat coils, the standard and the wire, and knowing the absolute resistance of the standard at a definite temperature, its temperature-coefficient, the rheostat calibration-corrections, and the temperature coefficient of the rheostat coils, a series of values for the correct resistances of the wire at different temperatures is obtained by formula (2).

Let $R_{t'}$ be the resistance of the wire at a temperature t'; R_t, its resistance at a lower temperature t; R_n, its resistance at the ordinary working-temperature n; O_n, its temperature-coefficient at n; then we have:

$$\theta_n = \frac{R_{t'} - R_t}{[t' - t]\, R_n}.$$

$R_{t'}$, R_t, R_n are all obtained from the series mentioned in the last paragraph.

The temperatures which the shunt, standard, and wire had at the time of balance were obtained as follows: (1). The three temperatures, with the corresponding time as indicated on a clock-face, were observed. (2). The time at which the balance was obtained was observed. (3). The temperatures again, with the corresponding time. From plotted curves, having times as abscissæ, and temperatures as ordinates, these temperatures at the time of balance were obtained quite accurately.

Correct values for the shunt resistance for use in formula (2) were obtained by (1) taking the mean of the observed values for both sides, I. II., of the commutator; (2) applying to these the calibration-corrections; (3) applying temperature corrections.

Correct resistances of the standard, also for use in (2), were obtained by the formula

$$R_{t'} = R_t\,(1 + \theta\,[t' - t]).$$

R_t may be obtained by any of the ordinary methods. θ for the standard was obtained from a comparison of the resistances of the standard and another wire by the method just described, using the other wire as a temporary standard, having had its approximate value of θ determined from a set of measurements of its resistances at different temperatures. The two wires were here wound on separate spools, the temperature of the temporary standard remaining nearly constant, being that of the laboratory, while that of the true standard was varied.

In all other observations for coefficients the wire under consideration was doubled at the middle, as was the standard, and wound on the same spool with the standard (see figure). The measurements were made with the spool immersed in kerosene, the thermometer being beside the wires. The bath was stirred before each temperature reading. The thermometer used was graduated to tenths of a degree, readable to half-hundredths; a degree occupying about one centimetre of the scale.

Observations were made near 12°, 18°, and 22° C, the middle being the temperature of the laboratory. They were combined—low with middle, middle with high, and low with high, thus avoiding errors from temperature-lagging.

The specific conductivity of the wire, referred to Siemens' units, was then determined. The wire was removed from its spool, its length, l, in metres and its diameter in millimetres measured—the latter by micrometer calipers. Then, C, being this specific conductivity, q, its cross-section in sq. mm., we have:

$$C = \frac{1}{1.06\ R} \cdot \frac{l}{q}.$$

R was obtained from the series of resistances employed in connection with the measurement of its θ. The factor 1.06 is introduced to reduce ohms to Siemens' units.

It remained only to get the value of conductivity θ, for

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[1] Leitfaden der Praktischen Physik, p. 854, 1857

[2] Ueber ein Verfahren, elektrische Widerstände unabhängig von Zuleitingswiderständen zu vergleichen. *Ann. Phys. u. Ch.*, xx, 1883. Here the inequalities of the galvanometer, if small, are eliminated; also the resistances of connecting wires.

the wire. These values for different wires are tabulated below. As the wires referred to in the table have different histories, as will subsequently be seen, and as the measurements were made as accurately as was deemed necessary, the mean value given is taken as the constant ratio sought. The number 8,410, reduced to have reference to ohms, becomes 8,915.

To sum up, it may be said, that, *having the resistance, R, in ohms, at a definite temperature, the length, l, in metres, and diameter, d, in millimetres, of a wire, we may get its temperature-coefficient approximate enough for ordinary use from the formula*

$$\theta = \left[\frac{l}{8915\ \pi . \left(\frac{d}{2}\right)^2 . R} \right] = \frac{l}{7{,}000\ R\ .\ d^2}.$$

The tabulated values obtained by means of this formula may be compared with those derived from actual measurement.

Wire.	Resistance @ 20° C.	θ = Temp. Coeff. @ 20° C.	Conductivity @ 20° C.	$\frac{\text{Conductivity}}{\theta}$	Mean $\frac{C.}{\theta}$	$\theta = \frac{l}{7000\ R\ .\ d^2}$.
Standard.	0.9148	0.0006629 0.000655[1] @ 10°	5.798	8800		0.00069
A	0.9220	0.000317	2.839	8900		0.00034
B	0.9176	0.000329	3.049	9300	8410	0.00036
C	0.9206	0.000320	2.452	7800		0.00029
D	0.9197	0.000372	2.722	7300		0.00032

Wire A was drawn in 1886, and obtained from the Scovill Mfg. Co., Waterbury, Conn. It contains 25 per cent. of nickel.

Wire B was obtained from Hartmann & Braun, Frankfort a. M., Germany, and was drawn before 1886.

Wire C came from Würzburg, and was drawn before 1886.

Wire D was obtained from The E. S. Greeley & Co., of New York city. It contains 18 per cent. of nickel.

POLYTECHNIC INSTITUTE OF BROOKLYN, May 27, 1891.

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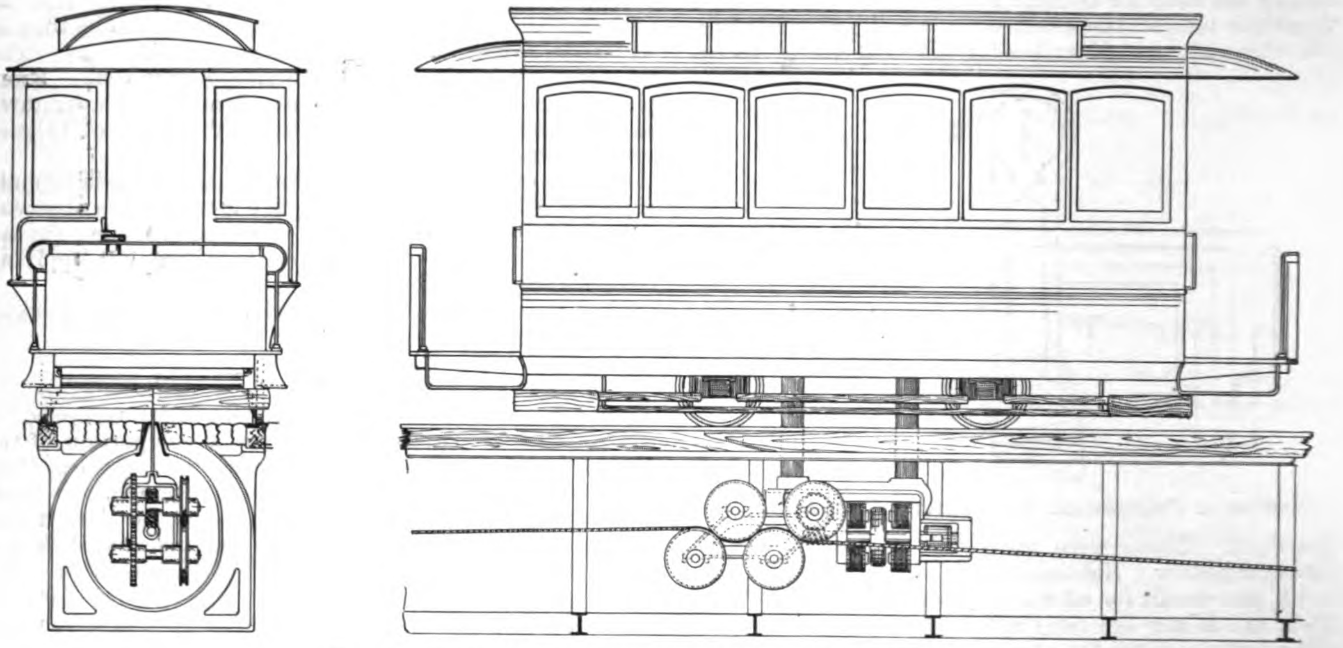
[1] This value determined by Vogel, of Würzburg.

QUACKENBOSS' CONDUIT ELECTRIC RAILWAY SYSTEM.

EXTENDED experience in the operation of cable roads has shown that, despite the utmost care, the wear of the gripping devices in their tearing, grinding and crunching action on the cable, renders it necessary to replace frequently both the grips and the cable, and though a large number of devices intended to obviate this destructive effects have been tried, they do not seem to have met the want.

In seeking a way out of this evident disadvantage, Mr. P. P. Quackenboss, of this city, reasoned that a rolling contact, if it could be applied, would be less liable to damage the surface of the cable. To satisfy himself of the correctness of this assumption he experimented with a short piece of half-inch "mine" rope and ascertained the fact that it was quite unnecessary to bend it half way round a drum in order to get traction. This convinced him that if he could use the old and well-known method of making the grip roll in unison on a taut rope held between two points, he would have, as it were, a flexible rail, on which could be carried any load, according to the capacity of the rope.

The next step, that of applying the power of an electric motor, was self-evident, and as there were many objections to using this method on the surface of the ground, it necessarily had to be placed in a conduit.



FIGS. 1 AND 2.—QUACKENBOSS' SYSTEM OF ELECTRIC TRACTION.

Various considerations had led Mr. Quackenboss to the opinion that the use of the heavy equipment of the cars using the electric motor was unnecessary, as city traffic does not require express trains, but smaller cars, and more of them; these, he believes, are better able to handle traffic at less cost for installation and maintenance. To successfully carry out such a system of small car units with a motor of reduced weight evidently necessitates some method by which the power can be applied as a "dead pull," acting in the same way as the pull of horses on a car. This has been accomplished in the manner shown in the accompanying engravings, Figs. 1 and 2, which show respectively a transverse and longitudinal section of Mr. Quackenboss' railway conduit system. As will be seen, the motor, instead of driving the car directly by gearing with the wheels, is flexibly suspended and runs in a conduit, throughout the length of which a cable is laid. This cable is taken up by a "grip" arrangement consisting of a few sheaves driven by gears from the motor shaft. The slight curvature given to the cable on its passage around the sheaves is ample to afford sufficient grip, so that, when the sheaves are revolved by the motor, the car is propelled with an absolute driving power.

This fact makes the progress of the car independent of the slipping of the wheels on an icy or snow-covered track, and, on the other hand, makes the climbing of grades as easy as if the wheels geared with a rack rail.

According to Mr. Quackenboss, the wear on the cable is not one-fourth as great as by the present method of gripping, and as the cable is only slightly deflected in its passage through the sheaves (not bent round a drum as is at present the method in elevators, etc.), and as no "tension" is required, the elastic limit is not reached, and a longer life is assured. Every part of the mechanism is easily got at through the man-holes at the side of the conduit, and the inventor claims that a system of this description will make regular trips at less cost per car mile, including maintenance and repairs, than those at present in vogue.

SOME EXPERIMENTS ON THE ELECTRIC DISCHARGE IN VACUUM TUBES.[1]

BY PROF. J. J. THOMSON, M.A., F.R.S.

THE phenomena of vacuum discharges were, Prof. Thomson said, greatly simplified when their path was wholly gaseous, the complication of the dark space surrounding the negative electrode, and the stratifications so commonly observed in ordinary vacuum tubes, being absent. To produce discharges in tubes devoid of electrodes was, however, not easy to accomplish, for the only available means of producing an electromotive force in the discharge circuit was by electro-magnetic induction. Ordinary methods of producing variable induction were valueless, and recourse was had to the oscillatory discharge of a Leyden jar, which combines the two essentials of a current whose maximum value is enormous, and whose rapidity of alternation is immensely great. The discharge circuits, which may take the shape of bulbs, or of tubes bent in the form of coils, were placed in close proximity to glass tubes filled with mercury, which formed the path of the oscillatory discharge. The parts thus corresponded to the windings of an induction coil, the vacuum tubes being the secondary, and the tubes filled with mercury the primary. In such an apparatus the Leyden jar need not be large, and neither primary nor secondary need have many turns, for this would increase the self-induction of the former, and lengthen the discharge path in the latter. Increasing the self-induction of the primary reduces the E. M. F. induced in the secondary, whilst lengthening the secondary does not increase the E. M. F. per unit length. The two or three turns as shown in Fig. 1, in each, were found to be quite sufficient, and, on discharging the Leyden jar between two highly-polished knobs in the primary circuit, a plain uniform band of light was seen to pass round the secondary. An exhausted bulb, Fig. 2, containing traces of oxygen was placed within a primary spiral of three turns, and, on passing the jar discharge, a circle of light was seen within the bulb in close proximity to the primary circuit, accompanied by a purplish glow, which lasted for a second or more. On heating the bulb, the duration of the glow was greatly diminished, and it could be instantly extinguished by the presence of an electro-magnet. Another exhausted bulb, Fig. 3, surrounded by a primary spiral, was contained in a bell-jar, and when the pressure of air in the jar was about that of the atmosphere, the secondary discharge occurred in the bulb, as is ordinarily the case. On exhausting the jar, however, the luminous discharge grew fainter, and a point was reached at which no secondary discharge was visible. Further exhaustion of the jar caused the secondary discharge to appear outside of the bulb. The fact of obtaining no luminous discharge, either in the bulb or jar, the author could only explain on two suppositions, viz., that under the conditions then existing the specific inductive capacity of the gas was very great, or that a discharge could pass without being luminous. The author had also observed that the conductivity of a vacuum tube without electrodes increased as the pressure diminished, until a certain point was reached, and afterwards diminished again, thus showing that the high resistance of a nearly perfect vacuum is in no way due to the presence of the electrodes. One peculiarity of the discharges was their local nature, the rings of light being much more sharply defined than was to be expected. They were also found to be most easily produced when the chain of molecules in the discharge were all of the same kind. For example, a discharge could be easily sent through a tube many feet long, but the introduction of a small pellet of mercury in the tube stopped the discharge, although the conductivity of the mercury was much greater than that of the vacuum. In some cases he had noticed that a very fine wire placed within a tube, on the side remote from the primary circuit, would prevent a luminous discharge in that tube.

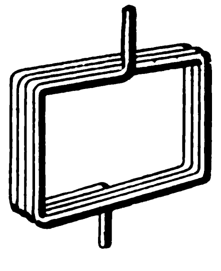


FIG. 1.

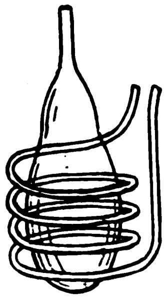


FIG. 2.

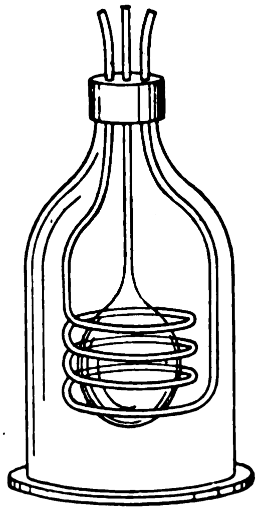


FIG. 3.

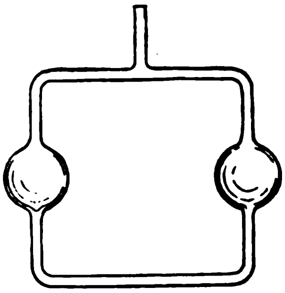


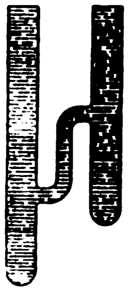
FIG. 4.

FIG. 4 shows an exhausted secondry coil of one loop containing bulbs; the discharge passed along the inner side of the bulbs, the primary coils being placed within the secondary.

SOME EXPERIMENTS ON THE VELOCITIES OF THE IONS.[1]

BY W. C. D. WHETHAM, B.A.

IN studying electrolysis, the question as to whether there is any transference of solvent when a porous wall is absent, presented itself to the author. The ordinary methods of testing for transference, such as by increase of pressure, or by overflow, not being available, when there is no diaphragm, the author used different colored solutions of the same salt, such as cobalt chloride in water and in alcohol, the former of which is red and the latter blue. By putting the solutions into a kind of U-shaped tube, any change in the position of the line of junction of the two liquids could be measured. Two aqueous solutions in which the anion was the same were also tried, one combination being cupric chloride and common salt, and in this case the line of demarcation traversed about 7 inches in three hours. The results hitherto obtained by this method agreed fairly with those found by Kohlrausch.



EXPERIMENTS ON THE VELOCITY OF IONS.

AN ELECTRICAL SNAKE STORY.

One evening, W. T. Reeves, manager of the Postal Telegraph Company, in Madison, Fla., found that his wires did not work between that point and Greenesboro. In the morning Mr. Reeves started out on an investigating tour. When within six miles of Greenesboro he found two mammoth snakes hanging across the wires in such a manner as to short circuit them. The snakes had been killed, tied together, and hung out to bring rain, the work being done by darkies in the neighborhood.

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[1] Abstract of a paper read before Physical Society.

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VOL. XI. NEW YORK, JUNE 10, 1891. No. 162.

The property of the inventor is not something which his patent enables him to subtract, to self-appropriate from the world's possessions, as in the case of the old monopolies. The whole world has become, and forever after his patent has expired will continue to be, stronger or richer for the new use he has taught it to make of the powers of nature; that is the highest creation open to human power.—James J. Storrow.

ELECTRIC METERS.

MUCH has already been written and said on the subject of electric meters, and that it is still one of timely interest was made evident by the discussion called forth by the paper on electric meters read before the American Institute of Electrical Engineers, by Mr. G. W. Walker. Although it was recognized at the outset that a meter must be included in any incandescent light system making claims to commercial practicability, and although incandescent lighting has experienced a development in this country far in excess of that in any other, it is nevertheless a fact, that there are proportionally fewer meters in use among us than probably anywhere else. It is true that the causes to which this state of affairs may be ascribed are rapidly, disappearing, but they still exist to some extent and were clearly brought out in the discussion alluded to. The consumer's natural desire to have a meter which gives some visible record of the current consumed, has led to the construction of a large variety of such devices, some of which are of unquestioned value. The slowness of their adoption would therefore appear strange, were it not that a factor is here brought to bear, that unfortunately weighs heavily against the adoption of any device, however meritorious, and that is, its cost. As Prof. Thomson pointed out, there is no difficulty whatever in producing a reliable recording meter, but the fulfillment of the two conditions, reliability and cheapness, has thus far not been attended with complete success, considered from the standpoint of the average electric lighting station manager. While Prof. Thomson, in order to meet this condition of affairs, was working in the direction of obtaining a meter which could be turned out for three or four dollars, Mr. Weston pointed to the disastrous results of the past era of cheap construction, both in the station and in outside work. The inconsistency of spending large sums of money for obtaining the highest economy in the station, and then providing unreliable means of ascertaining the consumption, was too apparent to require further comment. While the theoretically perfect meter may, therefore, be still a thing of the future, it is interesting to note that the Paris meter competition has resulted in the awarding of the first prize jointly to Prof. Elihu Thomson and Prof. Aron. Considering the fact that the first report of the Testing Committee, made about a year ago, failed to determine the selection of a meter for the city of Paris municipal stations, the present results point to a striking advance in a comparatively short space of time. It is certainly most gratifying that American apparatus should have secured the prize in this manner, and Prof. Thomson is to be heartily congratulated upon his new triumph abroad. The successful apparatus is his motor meter, though not the most recent type.

IN FAVOR OF THE SINGLE TROLLEY.

As noted eleswhere in our columns, the Supreme Court of Ohio has reversed the decision of the Cincinnati Superior Court, which, on the petition of the local telephone exchange, ordered the electric street railway people to substitute the double trolley system for the single, in order to prevent induction on the telephone circuits, from the "earth return." The opinion expressed by the highest court of Ohio is, broadly, that the highway is for intercourse and traffic, and that the electric road, so far from hindering intercourse, assists it, the introduction of the single trolley system, with the incidental use of the earth return, being but a further and legitimate extension of the principle upon which all street railway franchises are granted. This is, indeed, the broad, real issue, and it has always seemed doubtful that, even if telephonic troubles were unabatable by remedies, the electric railway would be banished from our streets because it interfered with the telephonic conversations of perhaps 5,000 people out of a population of 500,000, upon everyone of whom the electric roads were conferring a benefit, by giving in its best form the very service for which roads and highways are constructed. The objections on the score of troubling the telephone have been paralleled by those from some of the Eastern towns where the overhead trolley wires have been found to interfere quite materially with the success of circus parades. It is true that both telephones and circuses were here before electric street railways, and to that extent are entitled to consideration; but if it were a question of preserving just that which did the most good to the community, in its use of the thoroughfares, or of the earth, we think that the electric road would be the last thing to be abandoned.

But the situation has never reached that extremity nor is it likely to do so. We believe that this decisi on will be stimulative to ingenuity in devising means to deprive induction of its effects on telephone circuits. Even if it did not, it will help forward the more general use of metallic telephone circuits, in the resort to which a practical and effective cure is most assuredly found.

ELECTRICITY AT THE WORLD'S FAIR.

The Frankfort Electrical Exhibition has now begun to assume good shape, and promises to be both interesting and successful. It would not be a bad thing if Prof. Barrett and Mr. F. Sargent, to whom the electrical work at the Chicago World's Fair has now been committed, could run over to Europe this summer and see for themselves what has been done at Frankfort and note the chief novelties or lines of development. We believe that a month could be spent to advantage in this way, for no matter how much may be learned from reports on such a subject, actual observation is much to be preferred.

Matters electrical of the World's Columbian Exposition are progressing very satisfactorily, and work has now begun in earnest. The appointment of an electrical engineer attached to the Department of Electricity as assistant to Prof. J. P. Barrett, to work out the detail portions of the Professor's ideas and see that they are carried out, will shortly be made, but at the date of writing this appointment has not yet been definitely settled. Prof. Barrett's plans will then be turned over to Mr. Frederick Sargent, the electrical engineer of the Construction Department, to carry out in accordance with their requirements as regards erection and construction, and Prof. Barrett's assistant will also act under the instructions of Mr. Sargent as far as the latter may require his services.

THE FUTURE OF THE ALUMINUM PROBLEM.

The question whether the aluminum of the future will be produced by chemical or electrical methods is of the utmost importance, regarded scientifically, and has an important bearing when viewed from the commercial standpoint. As Dr. Wahl pointed out in his admirable paper read before the American Institute of Electrical Engineers, chemists have been spurred on by the success attained by the electrical engineer, in extracting the metal by the aid of the heat produced in electric furnaces, in connection with electrolytic action, and it is fair to assume that they will not give up the struggle without a serious attempt at recovering the lost ground. But Dr. Wahl also gave sufficient data to show that even in its present state the electrical method of aluminum extraction was more than able to withstand the competition of the purely metallurgical methods. While we have no fear, therefore, for the future of the electrical aluminum processes, we believe that improvements are necessary in order to bring this metal to the position which it ought to occupy in the arts. Complaints have from time to time been heard against aluminum, which, without doubt, can be traced directly to the fact that the metal operated with was not pure, and hence did not give the results which a better product would have furnished. A small percentage of impurities has a very large influence on the character of the metal and of the alloys of which it forms a part, and as the metal will probably be used more in the form of an alloy, it becomes of the greatest importance to so improve the processes of manufacture that complaints, on the score above mentioned, may no longer be heard.

CONSTANT CURRENT AND CONSTANT POTENTIAL TRANSFORMERS.

Although the constant current transformer has found but very little application at the present day in comparison with that of the constant potential type, it is well to bear in mind the conditions which govern these two types of converters. Thus, as Mr. Steinmetz points out elsewhere, in the constant potential transformer the magnetization, and therefore the iron loss, is a constant quantity, no matter what the load at which the transformer is operating, while the loss in the copper, of course, varies, as the square of the current. In the constant current transformer, however, the reverse is the case, the loss in the copper here being a constant quantity, while that in the iron varies with the load in the proportion of 1.7 power of the magnetization. In predetermining the efficiency of a system it would therefore be well to take into account the differences here pointed out, as under certain conditions of operation the series system might be found more economical than the constant potential.

The Quackenboss Traction System.

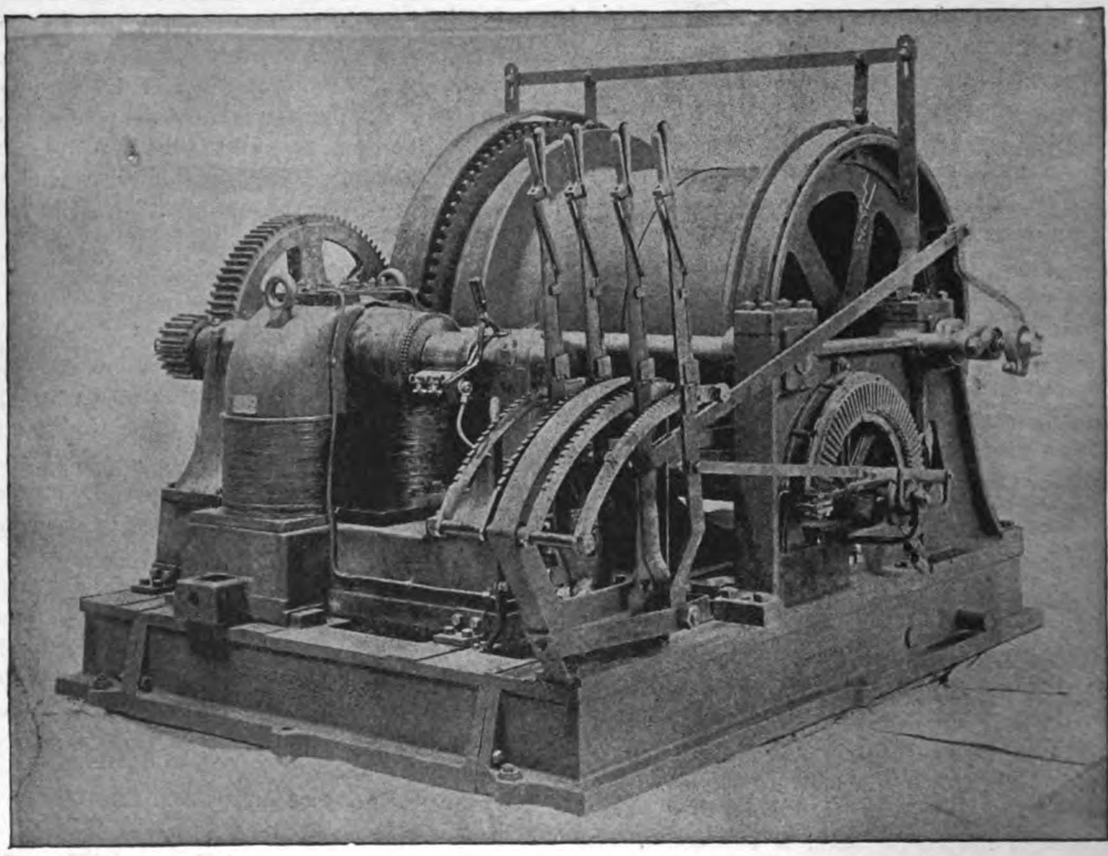
Of the various systems proposed for the application of electricity to tractive purposes, there are probably none which have afforded the car what might be called a "dead pull," with the exception, perhaps, of one or two isolated cases in which a rack rail is employed. The advantage which such a system possesses, especially on roads embodying heavy grades, is too obvious to need pointing out, and our readers will therefore be interested in the very ingenious device due to Mr. P. P. Quackenboss, and described on another page. It will be noted that the inventor obtains a direct pull for the propulsion of the car by driving a set of sheaves gripping a cable placed in a conduit, instead of applying the power to the car axles, as has heretofore been the case. The idea is one which is certainly worthy of further consideration.

A Chicago-Milwaukee Electric Road.

A scheme is on foot to build an elevated railway between Chicago and Milwaukee to be operated by electricity, in which it is stated a number of Baltimore capitalists, who have recently made a visit to Milwaukee, will be interested. It is proposed to organize a stock company of Eastern, Chicago, and Milwaukee capitalists with sufficient capital to build a direct road operated by electricity with double track between Chicago and Milwaukee, to be in operation by the opening of the World's Fair. This project, if carried out, will be watched with great interest as the first substitution of the electric locomotive for the steam engine on so large a scale, and over so large a run. It is to be hoped that such a scheme will not be entered upon without full consideration of its many important points, but, though it was expected that the more thickly settled East would see the first attempt at high speed electric traction, after all it may be that the newer conditions of the West are the more inviting.

A THOMSON-VAN DEPOELE MINE HOIST IN THE WEST.

AMONG the many advantages of the electric system of haulage for underground work is the ease with which the locomotive may be helped out, so to speak, where an incline occurs in the haulage way, by means of stationary electric hoists operated on the same circuit with the locomotive, and by their use making possible the employment of much smaller locomotives than would be possible otherwise. For instance, for certain haulage work in a coal mine, a 40 h. p. locomotive is necessary. As the entry is driven forward a fault is met in the measure, and the grade for a comparatively short distance is so increased that the locomotive, already in, will be unable to handle the work. An auxiliary stationary hoist set up at the top of this hill will remedy the difficulty. For this work special apparatus is necessary, and the Thomson-Van Depoele Electric Mining Co. has gotten out electric hoists particularly for underground haulage plants. The illustration shows one of these as recently made for a Western coal mine. The plant originally consisted of one hoist, but its work and the results obtained by its use proved so eminently satisfactory that two other hoists were immediately ordered.



THOMSON-VAN DEPOELE MINE HOIST.

The outside dimensions of the hoist are 9′ by 7′ 4″, and the total height is nearly 6′. The motive power is furnished by a Thomson-Houston motor of 35 h. p., and wound for a potential of 440 volts. It is series wound and runs normally under load at a speed of 1,100 revolutions per minute. A speed reduction from the motor armature to the drum of 25½ is accomplished by one intermediate shaft with proper gears and pinions. This gives a rope speed of a little over 500 foot per minute or 0.492 foot per revolution of the motor. The drum, which is mounted on a sleeve and is thrown into action with the large gear by a friction clutch, is four feet in diameter with a 36″ face. Its rotation, when running independently is governed by two band brakes which extend around nearly the entire circumference of the drum. The outfit is equipped with five controlling levers, four of which are shown in the illustration. One operates the rheostat contact, one the drum clutch, two are brake levers, which are entirely independent one from the other, and the last throws the reversing switch, giving the drum, when thrown into action with the motor, positive motion in either direction of rotation. The controling levers are all latched, and all within easy reach of the operator. The gears and pinions are noiseless and carefully covered to prevent accidents, and the motor has self-oiling bearings. The Thomson-Van Depoele Electric Mining Co. is getting out hoists of this general description in varying sizes and for different capacities, and will furnish estimates and information upon application.

OPENING OF THE FRANKFORT EXHIBITION.

Saturday, May 15th, witnessed the opening of the electrical exhibit at Frankfort-on-the-Main, under very favorable circumstances. A brief description of the principal features, although necessarily incomplete, may be of interest at this stage of the work. The boiler house, lying directly back of Machinery Hall, contains 21 boilers, of which 20 are now ready for actual service. These present a heating surface of more than 27,500 square feet.

In Machinery Hall there are more that 60 prime motors, many of which are already in use. Many of the dynamos are coupled directly to the engines, especially where both have been manufactured by the same firm.

Messrs. Siemens and Halske have in charge the erection of the central station, and their installation will shortly be complete.

Schuckert & Co., of Nuremberg, exhibit several steam engines and a number of dynamos and motors, and have undertaken to light a portion of the exhibition. The Thomson-Houston Co., of Hamburg, show two dynamos and an electro-magnet capable of sustaining a weight of one ton, intended for transporting iron castings in foundries.

The Helios Co., of Cologne, have a 600 h. p. steam engine by Panckseh, coupled to a 2,000 volt, 400 kilowatt alternator. This machine will deliver 30,000 watts for lighting the Palm Gardens at the other end of the town. Various other machines are also included in their display.

The entire output of the dynamos is estimated at 3,950 h. p. About 30 firms exhibit dynamos, motors, and transformers, while 20 show steam engines, and 12 gas engines. The transmission of 300 h. p. from Lauffen-on-the-Neckar has been delayed, and will probably not be accomplished before August 15.

The department for the distribution of electricity will exhibit transformers of all kinds, pressure regulators, automatic rheostats, etc. On either side of this building are workshops, the power for which is derived from Machinery Hall. The technical arrangements for these are in charge of engineers Sarasin and Stahl, who have some 35 motors of various types, ranging from $\frac{1}{16}$th to 25 h. p. at work.

Finally, on the left of Machinery Hall is an artificial mountain, under which is a model mine with an underground electric railway and electric boring machines, and over which flows a cascade lighted from below with electric light.

Reports of Companies.

MEXICAN TELEPHONE CO.

Treasurer W. French Smith reports for the year ended Feb. 28, 1891:

Cash Feb. 28, 1890	$5,273.86
Receipts in Mexico	76,068.79
Receipts in Boston	18,460.06
Total	$99,802.71
Increase for the year	21,909.16
Payments in Mexico	60,150.86
Payments in Boston	26,560.78
Cash on hand, Boston	12,100.19
Cash on hand, Mexico	990.89
Total	$99,802.71
Increase for year	18,071.30
Less extraordinary expenses	14,800.00
Making the normal increase	$3,271.30
Receipts in Boston, including a cash balance of $4257.16	38,660 97
Payments in Boston	26,560.78
Balance Feb. 28, 1891	$12,100.19

	1890-91.	1889-90.	Inc.
Telephones in service	1.123	1,045	78
Rentals for the year	$66,782	$54,773	$12,008
Gross earnings in Mexico	76,068	65,780	10,288
Operating in Mexico	41,818	41,301	516
Net receipts	12,504	16,522	......

WESTINGHOUSE AFFAIRS.

With regard to the further postponement of the Westinghouse annual meeting until June 23, and the progress of the scheme for reorganization, Mr. Bannister, the vice-president of the Westinghouse Electric Co., says:—"Mr. Westinghouse tells me that all that is necessary for the complete success of the reorganization plan is that the stockholders should come in at once and exchange their stock for the receipts of the Mercantile Trust Company. He says that he is meeting with very gratifying success, and that already more than half the total number of shares have been so deposited. Forty per cent. of the stock so released will be used to pay off a charge of $250,000, and this in itself will be a great relief. If the remaining stockholders will only send in their stock at once to the Mercantile Company, the meeting of June 23 will see the reorganization perfected and the company placed in a position which will enable it to do a bigger business than ever."

Society and Club Notes.

MEETING OF THE EXECUTIVE COMMITTEE OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

A meeting of the Executive Committee of the National Electric Light Association is to be held at Montreal, Canada, on the 8th inst., to arrange details for the coming convention.

An unusually active interest is being taken this year in the Montreal meeting, and it looks very much as though the attendance and objects of interest displayed will equal, and even exceed, those of former conventions. The popularity of this Association has been growing with remarkable vigor during the past few years until now the strength of the organization places it on a plane with the great societies, not only of this country, but of the world. This is deservedly so, owing to the very practical nature of its objects and labors, and the aid it affords to its members in a knowledge of the most economical and efficient solutions of the every day problems arising in the course of commercial work.

The immense Victoria Skating Rink at Montreal will be used for the purposes of the exhibition, as it has been found that a smaller hall would not be sufficiently large to accommodate the many who are anxious to obtain space.

THE ELECTRIC CLUB.

At the meeting of the Board of the Electric Club on June 4, there were admitted 33 new members—1 life, 6 active and 26 associate, showing that the late rapid rate of growth is being well maintained. About a dozen new applications already await the attention of the Membership Committee. The report of the treasurer showed that the finances of the club are in progressively healthy condition. From the statement of the House Committee it appears likely that should the lease by the club of its present quarters be extended a couple of years, as proposed, the sleeping accomodations will be increased, as there is a brisk demand for rooms all the time.

It has been arranged to have the smoking concert on the third Thursday of this month, June 18th, and the Entertainment Committee report that an excellent programme is now secured, with the probability of the addition of other talented performers from the electrical ranks. The concert will be preceded by a business meeting of the club.

Letters to the Editor.

OIL AS AN INSULATOR FOR HIGH TENSION CIRCUITS.

In your issue of May 13, page 540, there appeared an article signed by Mr. David Brooks, in which he quotes me as follows: "For conveying extremely high tension current, only the overhead system can be practically considered, and it is possible to construct an overhead line in such a manner that even with the highest voltage there will be practically no leakage."

I beg to remark that this is inaccurate and I should think that Mr. Brooks has seen a bad translation of my paper read in Frankfort, which was reproduced in the *Elektrotechnische Zeitschrift*, and by referring to which he will see that the above alleged statement is wrong. I have never stated that the overhead system only, could be practically used for currents of very high tension, but as the paper was especially read in the interest of the Frankfort-Lauffen installation, I suggested that in this particular case another way of transmitting the power over so long a distance would not be practical.

Mr. Brooks will undoubtedly admit that it is most important to find out the maximum tension at which an overhead line with naked wire on good insulators can be worked without considerable leakage, as economy in the line is always a point of first consideration.

The experiment to be carried out at the Frankfort exhibition will no doubt give us the desired information.

In conclusion, I must now inform you that I do not consider air a very good insulator, since my transformers for high tension are immersed in oil, which fact proves that our ideas on insulation are not opposed.

C. E. L. Brown.

Oerlikon bei Zurich, May 23, 1891.

Patent Notes.

ELECTRIC RIVETTING INTERFERENCES.—THOMSON vs. RIES.

With regard to the recent alleged victory of Ries over Thomson on electric rivetting, Mr. H. N. Sweet, of the Thomson Electric Welding Co., writes us that the reports are somewhat misleading. "The decision referred to," he says, "was that of the lowest tribunal in the Patent office, from whose conclusions there are two appeals. We believe the decisions of the Examiner of Interferences are wrong, and an appeal has already been taken and argued. This interference relates merely to a refinement of the inventions of Prof. Thomson already patented to him in patents which cover broadly the subject matter of the interference which is referred to. No electric rivetting can by any possibility be done without infringing patents already issued to Prof. Thomson, as a reference to those patents will show." We are informed (June 8), that an appeal to the Board of Examiners in chief has just been decided in Prof. Thomson's favor.

Appointments, Etc.

Mr. W. H. Cull has been appointed electrician of the Hudson River Telephone Co., of Albany, N. Y. He will give his immediate attention to the reorganization also of the messenger service.

Mr. E. Haston has become electrician and engineer at the Great Barrington, Mass., central station.

Mr. J. D. Bishop has become connected with John A. Roebling's Sons Co. as electrical engineer in their electrical department.

Mr. George E. Hanson, who established the Somerville service of the New England Telephone Co., has been transferred to the Boston office of the company to discharge new and more important duties.

Mr. Redington Fiske is to have charge of the Western division of the Boston surburban telephone service, with headquarters in Brookline.

Mr. I. O Wright is to have charge of the Eastern division of the Boston suburban telephone service, with headquarters at Somerville.

Mr. Carter, of the Thomson-Houston Co., has been engaged as electrician by Henry Newhall & Co., of Danvers, Mass.

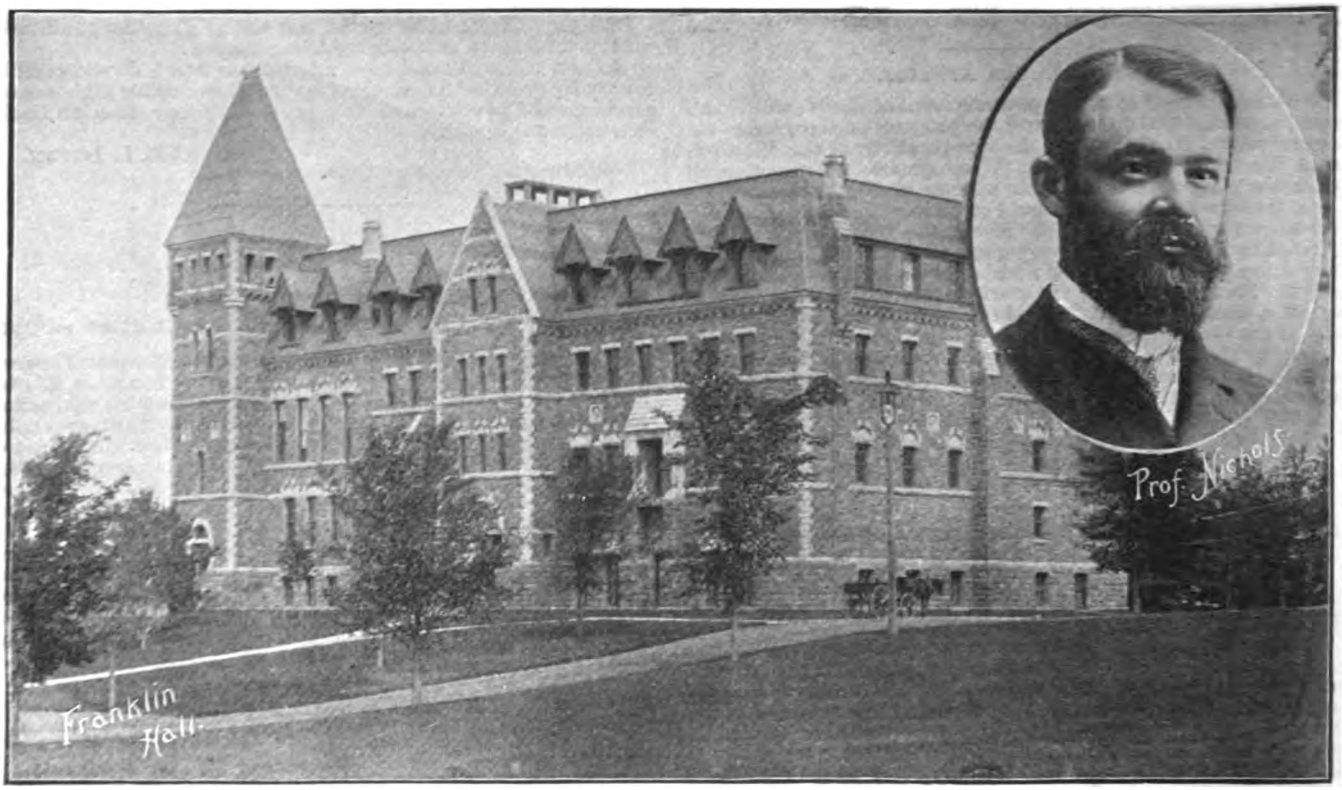
Mr. Eben Nevins, who has been chief engineer and electrician at the Plymouth, Mass., Electric Light Co.'s station, has taken charge of the power plant of the electric street railway at Newburyport.

College Notes.

CORNELL UNIVERSITY ELECTRICAL ENGINEERING DEPARTMENT.

The building exclusively occupied by the Department of Physics is called Franklin Hall, "in honor of the first American electrician," whose head in terra-cotta bas-relief adorns the doorway.

At the time of its erection in 1888, Franklin Hall, which was designed as a physical and chemical laboratory combined, was deemed ample for the accommodation of both departments. At the present time, however, the entire building is given over to the study of experimental physics. On the first floor is the large lecture room especially equipped for demonstrations. It is here that the student begins his acquaintance with the science which, if he be an engineer, will occupy more or less of his time during three years of his college course. Besides other recitation rooms, the cabinet of apparatus, occupying three large rooms adjoining the lecture room, and the laboratories for practice work in general physics, applied electricity, photometry, and practical photography, Franklin Hall contains many rooms where original investigation can be carried on. Research, indeed, is regarded as a very important feature of the work of the department, and it forms an essential element in the training of all advanced students in physics. Such students come to it well equipped after a year of lectures and recitations, a year in the junior laboratories, and a year of more difficult work in heat and applied electricity. At the head of the department is Professor E. L. Nichols.



FRANKLIN HALL, CORNELL UNIVERSITY, ITHACA, N. Y.

The dynamos that are used for University lighting, shown on p. 659, are arranged to be operated with the greatest economy and satisfaction, as well as to afford opportunity for complete "plant" testing by students of electrical engineering. They have been placed in the steam-engine laboratory in the closest proximity to the sources of water and steam power. For the incandescent lighting of shops, laboratories, and offices, current is obtained from an Edison 500 light dynamo, a gift to the University by Mr. Edison. Arc lamps in shops and armory and on the campus, are supplied with current from a 40-arc light alternator, presented to the University by the Westinghouse Electric Company.

The dynamos are so installed that they may be driven by water or steam power, or both. Ordinarily they are operated by water power, furnished by the turbine water wheel in the Ithaca Gorge, and are driven from the shop main-line shaft by belting through a jack-shaft. This connection to the line shaft is made automatically when the machines are to be started, so that the line shaft does not have to be stopped. The jack-shaft is equipped with friction-clutch pulleys of the most approved make, enabling each machine to be started and stopped independently.

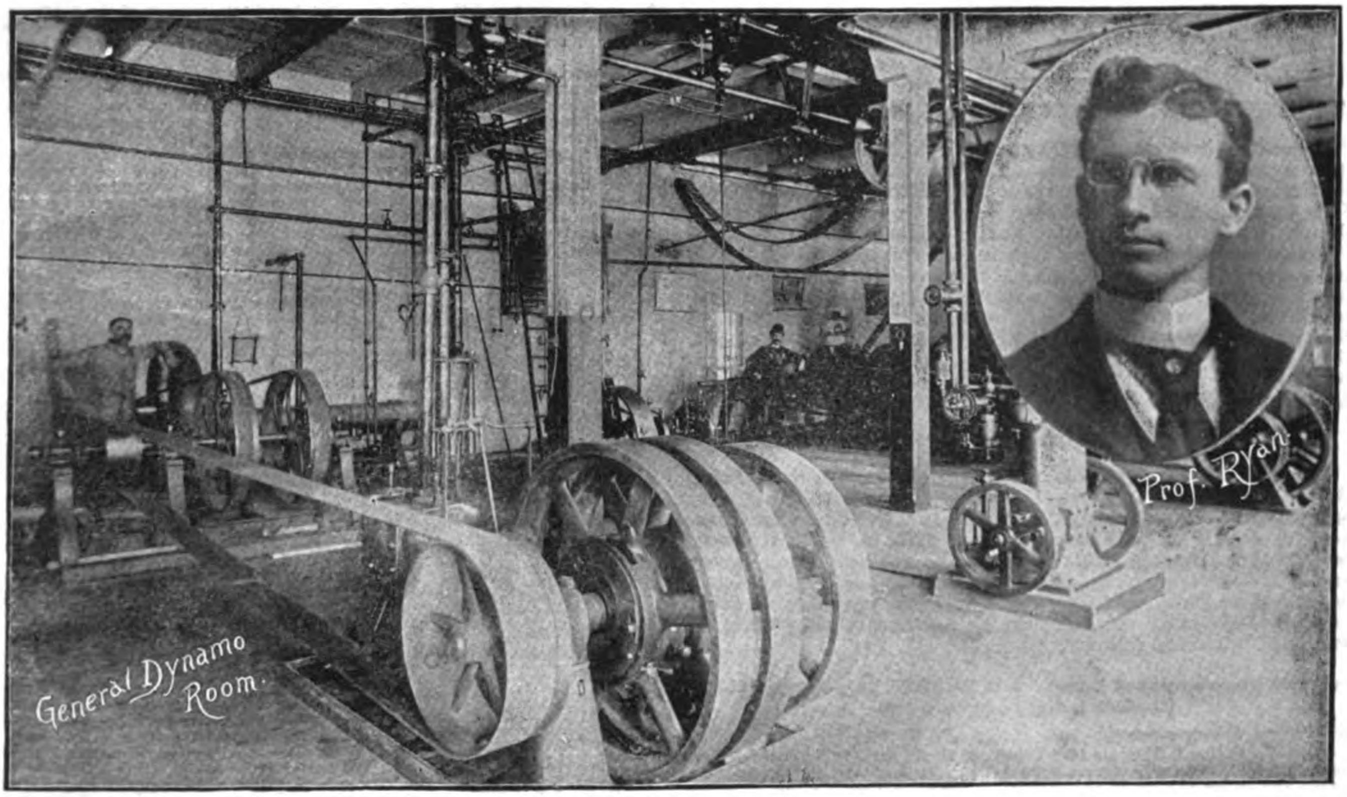
A Straight-Line automatic engine is so arranged that it can be belted to the jack-shaft at any time without stopping, and is thus used ordinarily to help the water-power over the maximum demand for power in the shops, and for lights, that occurs between five and six o'clock. The dynamo room is in charge of Professor H. J. Ryan.

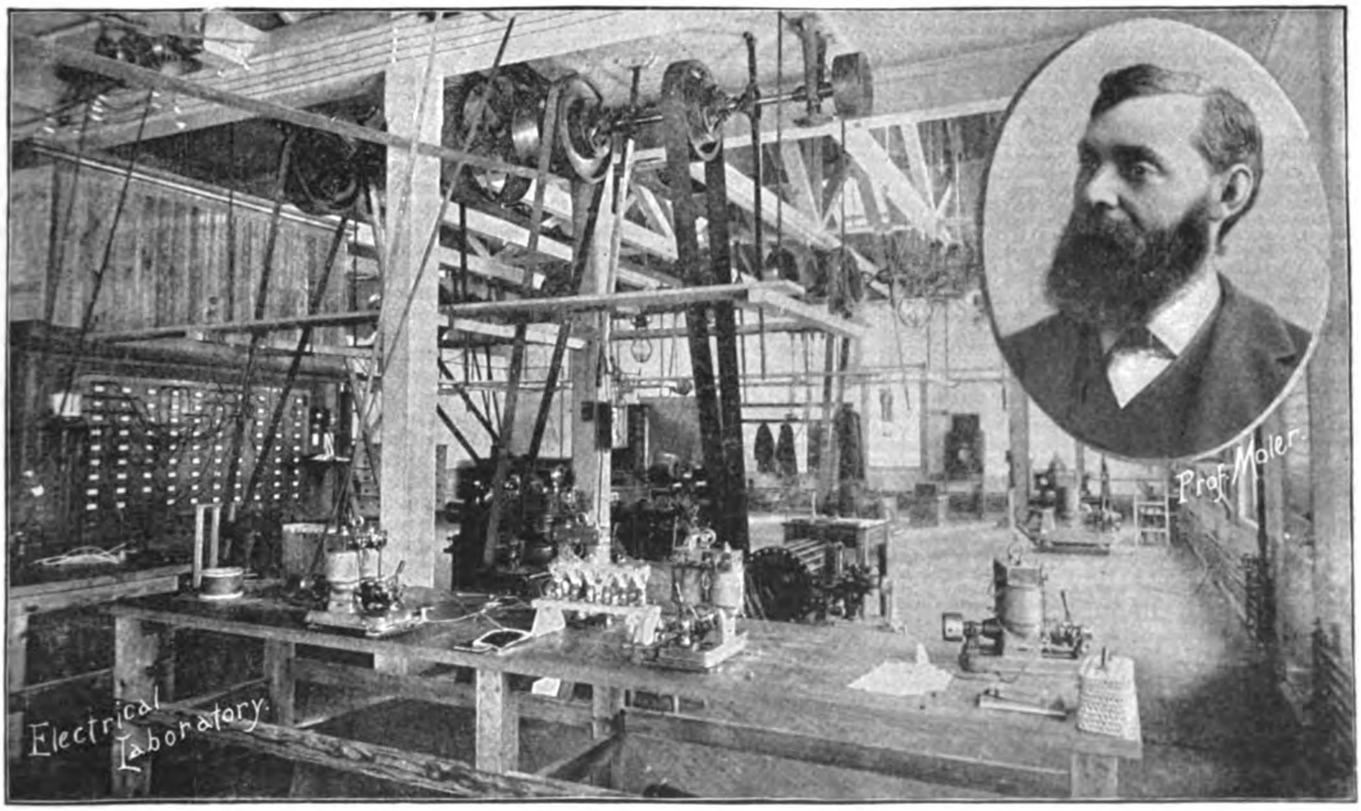
The Dynamo Laboratory, of which a view is shown on the opposite page, is believed to be the largest college dynamo room in this country, if not in the world. It contains no machines that are used in regular lighting service, but is devoted entirely to the experimental study of dynamos and motors The floor space is 40 x 70 feet; there are three lines of main shafting overhead that are driven by steam and water power. The collection of dynamos includes nearly all the well-known commercial types, together with many machines of unusual form, constructed especially for experimental purposes. These machines are of various sizes, from 20 h. p. down, and they are arranged with special reference to the requirements of experimental work.

An important part of the work in applied electricity, the measurement of currents and electromotive forces, together with a detailed study of storage batteries, arc lamps, voltmeters and electric meters, is carried on in the annex to Franklin Hall, which is a substantial one-story building 100 x 87 feet. Operations of extreme precision are conducted in the Magnetic Observatory, an isolated building entirely free from iron, which contains the great galvanometer and other standard instruments for measuring current and potential, and the magnetic elements. Professor G. S. Moler is in charge of this laboratory.

NEW ELECTRICAL WORK AT OIL CITY, PA.

The fact that a large electric light plant has just been installed at Oil City, Pa., in the very heart of the great oil region, deserves more than passing mention. The station of the local company is 94 feet by 57, and is built of brick with an iron bridge roof. The plant consists of four 60 arc light Western Electric machines, and one 1,000 light National alternating current machine. These dynamos are run from a line of shafting with Hill clutches, belted to two 260 h. p. four valve engines from Russell, of Massillon, O. The fly-wheels of engines are 10 feet in diameter with 36 inch face, and the pulleys on shafting are 46 inches in diameter with 36 inch face. The belts were furnished by the Munson Belting Co., of Chicago. There are two batteries of boilers made by the Oil City Boiler Works. A contract has been obtained from the city to light the streets for ten years with 91 lamps at $80 per lamp of 2,000 c. p., and it is expected to increase this to 125 lamps. This fine plant is being installed by Mr. T. L. Paulson, of the Western Electric Co., and is to be running about June 15. A charter has also been secured by another new local company for





DYNAMO ROOM AND ELECTRICAL LABORATORY, CORNELL UNIVERSITY, ITHACA, N. Y.

an electric railway. Mr. J. B. Smithson is one of the leading spirits of the enterprise. It is said that the road will soon be put in, but the system has not been selected as yet.

ELECTRICAL PROGRESS IN JAPAN.

The Tokio Electrical Society has appointed a committee of 15 to make investigations and publish rules and regulations as standard requirements for electrical installations. The telephone exchange of Tokio City, Japan, in charge of the government, is reported as very prosperous. The present number of subscribers is 320, while the population is 1,207,022, and the total number of houses 277,049. The Yokohama exchange has 70 subscribers. Nearly all the telegraph and post offices have been combined, and are now in a prosperous condition. An electric elevator is running every day at Tokio, in a tower. The current is supplied by the Tokio Electric Light Company. The motor used is a 10 h. p. Sprague. Experimental works are carried on at two or three different places in the Japanese Empire for refining copper by electricity.

Legal Notes.

THE EDISON INCANDESCENT LAMP LITIGATION.—I.

The action brought in 1885 by the Edison Electric Light Company against the United States Electric Lighting Company, in the United States Circuit Court for the Southern District of New York, came up for final hearing before Hon. W. J. Wallace, Circuit Judge, on May 25th. Eaton & Lewis, solicitors for the complainant company, were represented by Richard N. Dyer, Grosvenor P. Lowrey, Clarence A. Seward and Sherburne Blake Eaton, of counsel. Messrs. Duncan, Curtis & Page, solicitors for the defendant, were represented by Samuel A. Duncan, Edward Wetmore, Leonard E. Curtis, and Frederick H. Betts, of counsel. The preliminaries having been arranged, the hearing was adjourned to May 26th, at 11 o'clock, at which time the opening argument in behalf of the complainant was begun by Richard N. Dyer.

ARGUMENT OF MR. DYER FOR THE EDISON COMPANY.

Mr. Dyer said that this was a suit of the Edison Electric Light Company against the United States Electric Lighting Company, upon a patent of Thomas A. Edison for an improvement on electric lamps, granted January 27th, 1880, which patent, the complainant contended, covered the modern incandescent lamp with which we have of late years become familiar as a means of household lighting. Mr. Dyer then handed to the court a model of the lamp described in the patent, which latter he proceeded to read as follows:

Specification forming part of Letters Patent No. 223,898, dated January 27, 1880.
Application filed November 4, 1879.

***To all whom it may concern*:**

Be it known that I, Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, have invented an Improvement in Electric Lamps, and in the method of manufacturing the same (Case No. 186), of which the following is a specification:

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light. The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading-wires and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of 1 to 4 ohms resistance, placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading-wires and the carbon has been obtained by clamping the carbon to the metal. The leading wires have always been large, so that their resistance shall be many times less than the burner, and in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but 1 to 4 ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance of the lamp, the leading-wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented; hence the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly coherent highly-heated surface of the carbon. I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating-surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp-black and tar, its resistance may be made high or low, according to the amount of lamp-black placed upon it; that carbon filaments may be made by a combination of tar and lamp-black, the latter being previously ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seventy-one thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

All these forms are fragile and cannot be clamped to the leading-wires with sufficient force to insure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp-black and tar material be molded around it in the act of carbonization there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps; hence the burner and the leading-wires are connected to the carbon ready to be placed in the vacuum-bulb.

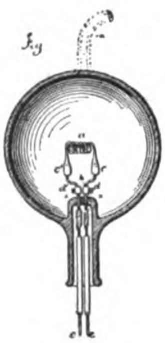
When fibrous material is used the plastic lamp-black and tar are used to secure it to the platina before carbonizing.

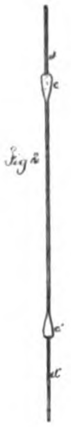
By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading-wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum-bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

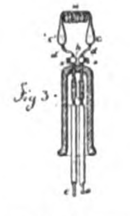
By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating-surface; hence I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp-black, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading-wires by plastic carbonizable material, and the whole placed in the carbonizing chamber. The copper, which has served to prevent distortion of the carbon thread, is afterward eaten away by nitric acid, and the spiral soaked in water, and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading-tube for exhaustion by a mercury-pump. This tube, when a high vacuum has been reached, is hermetically sealed.







With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the drawings, figure 1 shows the lamp sectionally. *a* is the carbon spiral or thread. *c c'* the thickened ends of the spiral, formed of the plastic compound of lamp-black and tar. *d d'* are the platina wires. *h h* are the clamps which serve to connect the platina wires, cemented in the carbon, with the leading-wires *x x* sealed in the glass vacuum-bulb. *e e* are copper wires, connected just outside the bulb to the wires *x x*. *m* is the tube (shown by dotted lines) leading to the vacuum pump, which, after exhaustion, is hermetically sealed and the surplus removed.

Figure 2 represents the plastic material before being wound into a spiral.

Figure 3 shows the spiral after carbonization, ready to have a bulb blown over it.

I claim as my invention:

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled or connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact-wires to the carbon filament and carbonizing of the whole in a close chamber, substantially as set forth.

Commenting upon the terms employed, Mr. Dyer defined subdivision to be the production of small lights capable of use in lieu of gas jets, at a cost which brought them within reach of the public. The important features of the Edison burner were its great resistance and its slight surface. The patentee believed, and complainants understood it to be the case, that former experimenters had worked in the direction of reducing, instead of increasing, the resistance of the carbon rod. The patentee had not only reversed the preceding practice, but he had made an important discovery upon which that reversal is based, namely, that carbon in a high vacuum has such stability that even a filament made by heating cotton thread out of contact with the air—very fragile and very delicate—even that small burner can be practically maintained in operation.

Reading again from the patent this sentence: "By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires," Mr. Dyer remarked that this was a significant statement, for by using carbon of such high resistance, it was possible to obtain light with minimum current; the small current also made possible the use of fine platinum wires, which could be sealed into the glass and would not heat and crack the bulb. He then read the first and second claims and stated that they were the ones claimed to have been infringed by defendant.

Mr. Dyer then handed to the court the lamps alleged to be infringed by the defendent, one being a Maxim lamp with M-shaped paper carbon, and another having a zig-zag carbon, also of paper. The third lamp had a zigzag burner of Weston tamidine.

Mr. Dyer said that to prevent any misconception of the scope of the patent as contended for by the complainant, he would read from the testimony of Professor Barker, complainant's expert, who was of the opinion that each of the three lamps contained all the elements of the first and second claims, combined and operating in the same way and for the same purpose. The coiling of the filament referred to in the patent was unnecessary when a steady current was employed, since the flickering was no longer appreciable to the eye. The differences in the material of the burners were merely matters of detail.

The invention of Mr. Edison described in this patent had several times been a matter of judicial interpretation and construction. In the English case against Woodhouse and Rawson the validity of the patent and the fact of infringement were both denied. The objections to its validity were, first, vagueness of description; second, insufficiency of instructions to workmen; third, that the patent did not describe a useful lamp, and fourth (a special English defence), that at the time of filing the final specification Mr. Edison knew of a better mode of manufacturing his carbon filament, and fifth, that the invention was not new in view of the state of the art, which embraced practically the same patents and publications as those in the present case, together with the Swan lamp, not available here as a defence, because neither patented nor published. Justice Butt held the patent valid, and the second claim infringed, and thenceforth the English litigation proceeded upon the second claim. This decision was affirmed on appeal January 31, 1887. A second suit was afterwards brought against Holland and others, and was decided by Justice Kay adversely to the patent, principally on the ground of insufficiency of the specification, in that it described certain methods which the court found to be impracticable. On appeal from Mr. Justice Kay, the case was decided by the appellate court, Lord Justices Cotton, Lindley and Bowen, February 18th, 1889, in favor of the patent.

In Germany in 1884, a suit brought to annul the Edison patent as invalid in view of the prior state of the art was decided in favor of the patent March 9, 1885; in a subsequent suit Naglo Brothers were held as infringers, but on May 5th, 1890, on appeal, the decision was reversed, and the Swan lamp made by Naglo held not to be an infringement. In the German case the question arose entirely on the first claim.

He came next to the case of the Consolidated Electric Light Company against the McKeesport Light Company, decided by Mr. Justice Bradley, October 5, 1889. The parties there were practically the same, except that the complainant here was the defendant there. Handing to the court a copy of the Sawyer & Man patent, the subject of that suit, Mr. Dyer said that Judge Bradley decided that what was described in that patent was not new and did not advance the art, but that what was described in the patent here in suit, was new, and was the particular invention which established the art of incandescent lighting. After filing the application for the patent in suit, November 11, 1879, Mr. Edison filed another application claiming paper as an incandescent conductor, thus attempting to patent a particular material which fell within the general scope of the first patent. Soon after Sawyer & Man filed an application upon the same thing; an interference resulted which was contested for several years, and finally decided in favor of Sawyer & Man. After this decision the application was expanded by amendments; Edison was no longer using paper but bamboo, so the application of Sawyer & Man was enlarged to cover fibrous materials generally, and upon that patent suit was brought. It was set up in behalf of Edison, not only that the use of paper was not new, but that Sawyer & Man were proceeding upon principles of construction proved over and over again to be impracticable, whereas that which was practicable, and which established the art of incandescent lighting, was Edison's invention of *the filamental carbon in a high vacuum in an all-glass sealed vacuum chamber*. So that when in this case Justice Bradley passed upon the question as to what the real invention was, all the testimony and all the state of the art was before him. Justice Bradley said that "the great discovery in the art was that of adopting high resistance in the conductor with a small illuminating surface, and a corresponding diminution in the strength of the current. This was accomplished by Edison in his filamental thread-like conductors, rendered practical by the perfection of the vacuum within the globe of the lamp." Again Justice Bradley said: "We think we are not mistaken in saying that but for this discovery, electric lighting would never have become a fact. We have supposed it to be the discovery of Edison because he has a patent for it. This may not be the case; it may be the discovery of some other person, but whoever discovered it, it is undoubtedly the great discovery in the art of practical lighting by electricity."

Having placed before his Honor the patent in suit and having referred to the decisions affecting it, Mr. Dyer said that before entering upon Edison's work he would proceed to explain some of the electric principles underlying the art. He then explained and illustrated by means of diagrams the distinguishing characteristics of the arc and the incandescent lamps; the meaning of the terms electromotive force, resistance and current, and the units of measurement which have been adopted, the whole being admirably illustrated by models showing sections of actual wires and rods of different metals and of different cross-sections. He also explained the difference between the *specific* resistance of a conductor, which depended upon its molecular structure, and its *absolute* resistance, which was determined by its form and size as well as by its material. The enormous difference in the resistance of a metallic and a carbon rod of equal dimensions was well illustrated in one of the models.

Continuing, Mr. Dyer said that the patent spoke of a filament of high resistance and small radiating surface. The radiating surface was quite as important as the resistance. It was important to remember that radiating surface might be varied independent of resistance. So far as resistance was concerned, it was immaterial what the shape of the cross-section might be, but every change in the shape of cross-section changed the extent of the radiating surface. This was illustrated by a model. The next important fact was that the quantity of heat developed in a conductor by the flow of the current was independent of surface, but the temperature to which the conductor was raised by a given amount of heat was directly dependent upon the surface. He desired his Honor to understand, that since the patent called attention to the fact that high resistance and small radiating surface were the objects of the construction, the foregoing explanations had a direct bearing upon the patent. A high temperature was absolutely necessary to produce light economically, and one way of securing a high temperature was by making use of a small radiating surface.

The object of this, and all other inventions relating to incandescent lighting, was to obtain a small light, a substitute for the gas jet for household illumination, and this necessitated a small radiating surface. Mr. Dyer illustrated this point by means of three lamps placed in series, each of 40 ohms resistance, but having different radiating surfaces. When the same current was passed through all the lamps, one showed a very bright light, one was only white hot, and the other barely visibly red.

A high resistance and small radiating surface made possible the use of a small electric current, but aside from the effect upon the light, the quantity of current determined also the size of conductor required to deliver it to the lamp.

Mr. Dyer then proceeded to explain at considerable length the relations existing between the quantity, pressure and energy of the electric current, and the arrangement of the translating devices in series and in multiple arc respectively, pointing out that when the incandescent lamp was to be used for house lighting, the multiple-arc system, making it possible for each lamp to be turned on and off independently, became necessary, and the great obstacle in the way of the use of that system, aside from the question of the practicability of the old lamps themselves, was that by reason of their low resistance and the large quantity of current required to operate them, they could not be placed in large numbers in multiple arc, except by the employment of conductors of enormous dimensions, which would make the cost prohibitive.

These explanations, continued Mr. Dyer, are necessary in order to appreciate the state of the art. An examination of the state of the art disclosed a lack of appreciation of those principles, or at least of such appreciation of them as would enable a practical lamp to be produced. These explanations enabled us to appreciate the function of high resistance and small radiating surface as elements in the economical production of light, and in the distribution of current without a prohibitive cost of conductors. The the function of the high vacuum and of the all-glass construction of electric lamp chamber, as well as a due appreciation of what had been accomplished by the invention in issue, could only be seen after an investigation of the prior state of the art, as it existed in the fall of 1878, when Mr. Edison commenced the series of experiments which resulted in the production, in October, 1889, of the lamp described in the patent in suit. There were two landmarks in the topography of the prior art; the patent of King in 1845, and the resuscitation of the art by Lodyguine in 1873. King described two lamps, one with a platinum burner, not in a vacuum, and another, more important in this case, having a conductor of carbon enclosed in a Torricellian vacuum. Criticising this lamp, Mr. Dyer said that it was admitted by all the experts connected with the case that it was not practicable to make an operative carbon conductor in the way described by King, viz: by mechanically reducing a rod of gas carbon. Again, it was a lamp of low resistance, from 1 to 4 ohms, subject to all the disadvantages pointed out in the patent in suit. It was a series lamp, as appeared by the patent itself, and could not be used in multiple arc. Dr. Morton, one of the experts for the defence, in an article in *Scribner's Magazine*, referring to the lamps of King and others, had said that the problem of commercial electric lighting by incandescent conductors, notwithstanding these inventions, yet remained without a solution. Similar statements had been made by Prof. Cross, another expert for the defense in this case. Prof. Brackett, testifying for the complainant, also showed that the vacuum must be very uncertain. Now it was not enough for the method to be capable of success in individual cases; it must be a method which could be applied commercially, and practically to the manufacture of thousands of lamps.

Mr. Dyer then proceeded to point out the inconsistency of the testimony of the defendants' experts, Prof's. Morton and Cross, in their testimony in the McKeesport case and in the present case, in reference to the lamp of the King patent. He next referred to the Roberts English patent, pointing out that it described a conductor of low resistance made by reducing material already carbonized, and contained in a chamber of a character in which we now know it to be impossible to maintain a vacuum. He further pointed out that the radiating surface and the resistance of the burner played no part in these lamps; inventors had not come to consider these matters; while Edison had taken up the art where the electric light had been produced, and he endeavored to produce it practically; to make a lamp which could be used without enormous expense for conductors, and which should be a simple piece of apparatus that could be handled by the public.

Mr. Dyer next referred to the abortive attempts of experimenters to produce a sub-divided electric light by Geissler tubes, and then took up the consideration of Crookes' radiometer, in which an electric current was passed through a platinum wire enclosed in a sealed and exhausted glass globe, in order to produce a source of radiation within the chamber to act upon revolving vanes. Of course there was no idea of making an electric lamp or a radiating surface or anything of that kind. It would probably not be contended by defendant that these devices directly anticipated the patent, but that the Geissler tube taught constructors of electric lamps how to seal a platinum wire into glass, that the radiometer taught them how to form high vacuum and that there could be no invention in bringing these elements together, as had been done in the patent in suit.

Mr. Dyer then briefly referred to the lamps of prior inventors put into evidence in the case; those of Konn, Lodyguine, and Fontaine.

The period during which these lamps were produced was one of active experimentation, having its centre at Paris. The Jablochkoff candle was then being employed in lighting the streets of that capital, and everything seemed ripe for the introduction of a divided electric light for interior illumination, provided a suitable lamp could be had. To determine the value of known systems of incandescent lighting, Fontaine experimented with several Konn lamps and the results were published in his book in 1877. He says that the vacuum, never being perfect in the receivers, the first carbon was in greater part consumed. There was also a kind of evaporation which continued to slowly destroy the incandescent rods—an evaporation clearly proved by the deposit of carbon on the interior of the bells. Here then, said Mr. Dyer, was a vital defect; notwithstanding the carbons were removed from oxygen and not consumed, yet they were volatilized; they were without stability even in an atmosphere which would not support combustion. What was the effect of this upon the art? Swan, an early English experimenter, forcibly sets forth the effect of the discoveries of Fontaine upon the progress of the art and of subsequent experimentation. He says:—"In all the various attempts to utilize the principle of the incandescence of carbon in vacuum, two great difficulties have stood in the way and baffled every attempt to overcome them. One was the rapid wearing away and consequent breaking of the incandescent carbon, and the other the obscuration of the lamp by a kind of black smoke."

Quoting Fontaine's statements, Swan said: "If this idea of the volatilization of carbon were founded in fact, any further attempt to render incandescent carbon lamps durable by means of a vacuum would be mere waste of time, and durable they must be to be of any practical value." These views were reiterated by Schwendler, writing in 1879. Such was the impression that the discoveries of Fontaine left upon the art, and hence it was of great importance to understand that the art, as it stood when Edison took up the matter, absolutely excluded the idea of obtaining success by the use of carbon. In support of this position Mr. Dyer quoted from an article by Dr. Morton in the *Gas Light Journal* of October 17, 1878; his report to the Lighthouse Board in November, 1879, and the work of Bernstein on electric lighting. The concrete problem was that known as the sub-division of the electric light. The electric light had its commercial embodiment only in the arc-light; the great problem awaiting solution was a sub-division that would furnish lights comparable with an ordinary gas jet, which could be turned off and on at the will of the user. Commercial considerations required that subdivision should be economical; that one generator should operate a considerable number of lights situated at considerable distances. Other conditions were that the first cost should not be excessive and the operation simple and certain. It was a matter of very great moment to defendant that the court should understand that each prior experimenter not only believed that a carbon lamp could not be made durable, but that the incandescent lamp could not be used in large numbers to produce small lights. Mr. Dyer, after reading from Fontaine's book the account of the celebrated experiment in which he believed he had disproved the divisibility of the electric light, repeated the experiment with a group of lamps connected with a battery, demonstrating that a current which brought one lamp to a condition of brilliant incandescence was insufficient to render five lamps visibly luminous. Mr. Dyer explained that the fallacy underlying these experiments was the assumption that the smaller lights should be produced by passing a smaller current through the same lamp; for in such case the burner had a lower temperature and as the temperature decreased, the light diminished in an enormously greater ratio. Had Fontane known how to construct lamps of high resistance and small radiating surface, he would have come to a different conclusion as to the possibility of subdividing the electric light. Mr. Dyer then illustrated this point by exhibiting five lamps of high resistance and small radiating surface, showing that under these conditions each of the five lamps gave its full quota of light, and was not materially affected by turning the others off and on. "This, your Honor," said Mr. Dyer, "is success; the other may be characterized as failure." At this point the court adjourned for the day.

The next morning, Mr. Dyer, resuming his argument, said:—Early in October, 1878, great publicity was given through the daily press to the announcement that Mr. Edison had discovered an electric light which solved the problem of sub-division, and could be supplied with great economy. Thereupon the question became a matter of discussion, and various men of science conscientiously believing that sub-division was impossible, or its accomplishment remote, felt called upon to express their opinions, in order to allay the commercial disturbance due to the great depression in the gas interests caused by the announcement of Edison's discovery. The deductions of Fontaine were mathematically proved to be correct, and the subdivision of the electric light was pronounced practically and theoretically impossible. Mr. Clarke, a witness for the complainant, has collected and placed in the record many pertinent extracts showing the general acceptance of Fontaine's demonstration, and the subsequent mathematical proof, furnished by Mr. Preece, a noted English electrician, that the light, with lamps in series, decreases as the square of the number, and in multiple-arc as the cube of the number. Says Mr. Preece: "It is this partial success in multiplying the light that has led so many sanguine experimenters to anticipate the ultimate possibility of its extensive sub-division—a possibility which this demonstration shows to be hopeless, and which experiment has proved to be fallacious." Similar expressions of opinion were read by Mr. Dyer from a letter of Prof. Silvanus Thompson in *Engineering*, in 1878, and from the testimony of scientific writers before the parliamentary committee in 1879. He also referred briefly to the work of others contemporaneous with Mr. Edison, to show that, with the exception of Lane-Fox, nobody except Mr. Edison appreciated the conditions upon which success was to be obtained, and he (Lane-Fox) only as an unattained desideratum, for he made no practical suggestion for obtaining those ends. And in respect to this, it appears by the record that Mr. Edison was prior to him in that appreciation, and so far as reaching a practical lamp goes, Mr. Edison reached that first. In 1879 appeared another edition of Fontaine's book, from which extracts were read tending to show that no subdivided incandescent lamp was known at that time. The work of Sawyer & Man, which appears at length in the record, was carried on contemporaneously with that of Edison. It was sufficient for the present to say that the entire matter was investigated by Mr. Justice Bradley, with the result already before his Honor, the conclusion being that they were pursuing the wrong principle and did not reach success. Mr. Dyer then referred to the experiments of Farmer with the platinum lamp, as given in the publications of Prescott and of Sawyer, and then passed to the consideration of the Lane-Fox patent. Quoting from the English decision, in which the court, among other things, said, "When he comes practically and finally to deal with the matter, he disclaims it and drops it out of his patent. Why? Evidently because he did not know how to make an efficient carbon conductor. The carbon conductor he describes—he must have thought, and he says in fact—was less desirable than the metallic under all circumstances; and he did not know how to make one that would be better."

That Lane-Fox had very clear and advanced notions as to what was necessary for a practical system no one could doubt. The closing paragraph of his letter in the London *Times* of December 26, 1878, evidently refers to his own experiments with incandescent lamps, and to the hope he had that he would yet be able to make a practical lamp. He undoubtedly had the ambition to be first in that respect, but that he was not first, he himself admitted in a discussion before the Royal Institution in 1881. Sir William Thomson, probably the foremost electrical engineer of the time, when asked how in the fall of 1879 he would have had advised the placing of 500 incandescent lamps, had replied: "I should certainly have advised against any such arrangement, as no incandescent lamp was known at that time which could possibly have given a satisfactory result." Mr. Edison's work in the fall of 1878 and the early part of 1879, prior to the actual grant of the Lane-Fox patents, showed that he had the same appreciation of high resistance and small radiating surface earlier than any effective date which can be given to the Lane-Fox patent in this country, and Mr. Edison could not have received from those patents his knowledge of the necessity of high resistance and small radiating surface. The testimony in the Sawyer-Man interference, in evidence in this case, furnishes material from which we can gain an idea of Mr. Edison's work, and in the present case also the defendant called Mr. Edison and examined him somewhat cautiously, getting from him statements which furnished additional material of like character. It appears that in 1877 Mr. Edison made experiments which demonstrated that carbon had no considerable life under conditions then attainable, and the experiments were discontinued until renewed in the fall of 1878. Sketches in the record show that even at this early period Mr. Edison appreciated that for a multiple-arc arrangement of lamps he needed a high resistance. In August, 1878, he resumed work. Experiments upon incandescent carbon under the receiver of an air-pump were hardly more successful than those of the previous year, but proved that carbon was an unsuitable material under the conditions then obtainable. Mr. Edison testifies: "Our calculations showed us that the lamp must have at least 100 ohms resistance to compete successfully with gas." He further says that he knew he could get the requisite resistance and small radiating surface by means of carbonized paper or wood, and therefore while working to accomplish this by means of platinum, he endeavored by a more perfect vacuum to obtain incandescent conductors of carbon which would give the result. "*The great point we desired,*" says Mr. Edison, "*was a lamp of high resistance and small radiating surface, and it did not matter very much whether it was of carbon or of platinum.*" The platinum lamps to which he refers are shown on the chart (indicating), one being the platinum lamp of 1878 and the other of 1879. The latter has a platinum wire wound on a bobbin and sealed into an all-glass globe, the highest perfection probably ever reached by a platinum lamp. But, as Edison testifies, notwithstanding the platinum was in a high vacuum, it was still subject to disintegration, the phenomenon which prevented all platinum lamps from being a success. Respecting the transition from the platinum to the carbon filament lamp of the patent in suit, Mr. Edison, testifying in 1881, stated that when he had ascertained that he could get a high vacuum with a Sprengel pump, it occurred to him that perhaps a filament of carbon could be made to stand in the sealed glass vessel, exhausted to a high vacuum, which he was then using, and in October, 1879, he made lamps of paper carbon and of common sewing-thread, placed in a receiver made entirely of glass and exhausted to nearly one millionth of an atmosphere. "We had reached the condition," says Mr. Edison, "where, notwithstanding the carbons were small in mass and filamentary, they were stable sufficiently so to allow of the economical subdivision of the electric light and the possibilities of competing commercially with gas." "It was the new conditions which caused this lamp to be a success, which conditions were high vacuum in a receptacle in which no deterioration or lowering of the vacuum occurred to destroy the carbon." "It was the discovery of the stability of carbon, even when filamentary, enclosed in a high and stable vacuum, which made the modern incandescent lamp possible." . . . . "It was in that particular lamp that I discovered this all-important fact, that something which was expected to take place, did not take place; and this discovery permitted the use of fine filaments and carbon of high specific resistance, and made incandescent lighting, as we know it, commercially practicable." Being asked what led him to expect that if the carbon was placed in a highly exhausted all-glass vessel it would remain stable, Mr. Edison replied: "I thought that it would remain stable as far as oxidation was concerned, but I did not, as I stated before, think it would stop the disintegration of it entirely, because I had read something about incandescent lamps, and it seemed that they all universally stated that there is a deterioration; that a great many persons who have experimented with incandescent lamps stated that there is a blackening of the globe. Now, this blackening could not be due to oxygen, because the oxygen would form carbon monoxide. I saw, independent of the oxygen, there must be the matter of disintegration that I was afraid of, but I thought that perhaps that, having got rid of all oxygen, this distribution would not be so large a factor as to prevent the use of a lamp for commercial purposes.

"It is to this discovery," continued Mr. Dyer, "that we wish to appeal, as showing beyond all doubt that there was invention in this lamp produced by Mr. Edison, and invention of the very highest character." Referring to the 1878 experiments, Mr. Edison's principal assistant, Batchelor, says: "Our conversation frequently was directed to getting the highest resistance in the least possible space. I remember once or twice during these conversations early in 1879, Edison remarked, 'How easy it would be to get this resistance if carbon were only stable.'" Mr. Upton, another assistant, testified that he measured the resistance (cold) of one of these carbons, which was then burnt for a number of hours and again tested and no change found in its resistance. "I remember," says Mr. Upton, "that we all felt very much elated at the carbon not changing its resistance, for it showed that there was no wasting away of the carbon."

Mr. Dyer then exhibited drawings showing the evolution of the Edison lamp, beginning with the one in which the discovery of the stability of carbon was made, passing to the lamp of the patent; the lamp of November, 1879, and finally the bamboo lamp now made. He then described the successive steps of the process by which the carbonized bamboo burner was made and mounted in the lamp. He next exhibited samples of conductors of the thickness required to feed 100 16-candle lamps 100 feet from the generator at 110 volts pressure, and compared with that a bunch of 400 similar wires, such as would be required to accomplish the same thing with the old lamps having the carbon rod. Mr. Dyer said this illustrated, more forcibly than could be done by figures, that to use a lamp of that kind in multiple arc the cost would be absolutely prohibitive. Mr. Edison's experiments had shown that the carbon in an atmosphere of nitrogen at atmospheric pressure, the method adopted by Mr. Sawyer, required nearly twice as much electricity to produce the same candle power as when the burner is in a high vacuum. The vacuum itself is a cause of great economy. The defendant has attempted to show that even in the modern lamp there is a gradual blackening of the globe, and will probably argue that there was no discovery of the stability of carbon by Mr. Edison, because, as a matter of fact, carbon is not stable, even in the modern lamp. This disintegration does go on, even in modern lamps, but not enough to make the lamps uncommercial, and there was, indeed, a discovery in finding how disintegration might be reduced and the lamp lifted from failure to success. Defendant may argue that it is simply a matter of degree, but that which can turn failure into success certainly could not be so characterized.

The invention having been made, it remained to find the best material for the purpose and the most suitable form to give the burner. For his first public essay Mr. Edison employed carbonized Bristol board in horseshoe form. In December, 1879, a private exhibition was given, and near the end of the same month a public exhibition attended by thousands of visitors.

Mr. Dyer then briefly outlined the commercial development of the incandescent lamp in Mr. Edison's hands. After this exhibition, he said, the criticisms of scientists and electricians were renewed. In this second attack, as before, Dr. Morton was in the van, hastening to pronounce that a failure which he had not seen. He read Dr. Morton's letter in the *Sanitary Engineer*, and an interview in the *New York Times*, published December 28th, 1879, in which he said: "All attempts up to the present lamp in this direction are acknowledged to be failures, and as I have pointed out there does not seem to be any novelty which would authorize us to hope for a better success in the present one." The journals were full of criticisms of the same character. Then came an account of Mr. Edison's light by Mr. Upton in *Scribner's* magazine in February, 1880, which was the occasion for a renewed attack by the writers and critics. Secure in the possession of a practical lamp, Edison continued his work, feeling that scientific ignorance must finally give way in the face of commercial accomplishment. Actual tests by Professors Rowland, Barker, Morton, Brackett and others, and the commercial introduction of the lamp, soon confirmed the accuracy of the claim advanced for Mr. Edison, and showed that the electric light could be subdivided and that the lamp was a durable one. But the skepticism of the European electricians was not overcome until Edison exhibited his apparatus at the Paris Exposition in 1881, at the close of which Mr. Edison was awarded diplomas, medals, etc., and finally an especial diploma of honor, and the decoration of the Legion of Honor. The report of the Exposition commission shows, that although there were infringers and imitators present, yet Edison was in the van of progress, and was making the best lamp in the market. and has continued in that position to the present time. In the spring of 1880, the steamship "Columbia" was lighted with Edison paper carbon lamps; later in the same year, bamboo, which has ever since been used, was adopted as the basis for the carbon filament. It appears by an official bulletin of April 6th, 1883, that a central station plant had then been in operation in New York city for several months without stopping night or day. By October 31st of the same year, the station was lighting 508 houses wired for 12,000 lamps. The business has since grown to enormous proportions, with capital invested aggregating tens of millions and at the present day the number of lamps alone manufactured throughout the world by a conservative estimate is between 75,000 and 100,000 per day. Complainants therefore claim for the invention of Mr. Edison the merit of great utility, and for his patent that liberality of construction which the courts in the past have applied to patents upon inventions of this character.

The defendant's experts take the position that, in view of the state of the art, no invention was required to produce the lamp of the patent in suit. If these experts could not at once have made the perfect thing, the difficulties met could have been remedied, they think, as they arose by an intelligent application of existing knowledge. He would leave this position to the court without discussion, were it not that it afforded an opportunity for the criticism of these gentlemen, in the capacity of experts competent to instruct the court upon this subject. These same gentlemen, when the necessity arose in the McKeesport case, for making a place in the art for the Sawyer and Man arch-shaped fibrous carbon, treated the prior state of the art as entirely inadequate to supply a practical device. A large gap existed in the art, which it was necessary to fill before incandescent lighting could become a commercial fact. Judge Bradley agreed with them that the gap existed, but decided that it was not filled by the arch-shaped fibrous carbon of Sawyer and Man, but by the filamentary burner and high vacuum of Edison. Now that there is a change of attitude, these gentlemen find no difficulty in disagreeing with their former testimony and with the decision of Judge Bradley, and they say there was no gap at all. What reliance can be placed upon statements of facts or expressions of opinion given by these experts?

In an article in *Scribner's Magazine*, for August, 1889, while the McKeesport case was under consideration, Dr. Morton said:—"The problem of commercial electric lighting by incandescent conductors yet remained without a solution. This was the state of affairs up to the fall of 1878," adding that at that point of time, Sawyer and Man came in and solved the entire difficulty. He continued: "It is to Mr. T. A. Edison, without doubt, that we owe many of the simplifications and modifications, which, by cheapening the lamp and diminishing its weight, have extended its range of use and its usefulness to a remarkable degree." If Sawyer and Man had succeeded in the McKeesport case, it would be quite immaterial whether Edison had improved upon that lamp. Justice Bradley has removed Sawyer and Man from the prominent position given them in the art by Dr. Morton, but there is left a beneficial residuum, viz., that the problem remained without solution, and that what Edison did extended the range of usefulness of the electric lamp in a remarkable degree.

As to Professor Cross, it appears from the record that his opinions vary with a change of client and a change of retainer. He was employed by the complainant company, when it contemplated bringing suit in 1881, on the same patent against the same defendant, and against the same lamp—the M lamp. In reply to specific questions, after examination of the patents and publications, he concludes that the Edison patent describes a practical advance in the art; that such advance in the art was made use of in defendant's lamp, and that defendant's lamp was of "high resistance," although only of 43 ohms; judging from his deposition in this case, his views now seem to be entirely changed.

With regard to the construction of the patent, Mr. Dyer said he would briefly allude to the question of the meaning of the term "filament of carbon," appearing in all the claims as descriptive of the lamp burner. Both in the English litigation and in the present suit, it had been contended that the definition was vague, indefinite and uncertain; and that a determination of the meaning of the term is necessary in order to exclude old and include new lamps; that is, the defendant's lamps. Complainant would contend that this mathematical certainty is not necessary. So long as defendant's lamps are distinctively of a filamentary character, there could be no reason for a discussion as to how much larger they might be and still be within the terms of the patent. He would hand his Honor a lamp put in evidence to show the distinctive filamentary type of the largest carbon used by defendant. Defendant has suggested that the proper construction of the term "filament" may be a burner of at least 100 ohms resistance hot, this being about one-half its cold resistance. The object of that contention was this: Under the present affiliation of defendant with the Westinghouse company, a system had been introduced of distributing electricity by alternating currents at high pressure which made possible the use of lamps of 50 or 60 ohms resistance. So if defendant succeeds in that contention, they will be able to go on with their business in future under that system using lamps of less than 100 ohms hot. The patent office model shows what Edison contemplated under the patent. A lamp made in the proportion of the model, measured 80 ohms cold and 40 ohms hot; practically the same as the lamp of defendant about which this question arises. As a matter of fact, defendant's M lamps have been used in multiple-arc circuits in large numbers.

The difference between the filamentary and the rod lamp is shown in tables which have been prepared. From the patent the smallest filament has been taken, said by Prof. Barker to be five-thousanths of an inch diameter after carbonization. Then a number of the old lamps; Sawyer & Man; millimetre carbons; Adams' lamp; Sawyer feeder lamp, etc. Referring to the second column, giving ratios of cross-sectional areas, the filaments run from 1, the smallest tar-putty filament, to 9, and then jumps from the largest filament to the smallest rod; from 9 to 39. Conversely, resistance being inversely as the radiating surface, we have in the next table, with the largest rod as 1, a jump from the smallest rod at 16 to the largest filament at 69. In the last two columns of table 2 the ultimate comparison is reached; the ratio of surface per unit of resistance. The largest filamentary burner is placed at 27 and the smallest rod at 244; and if to this is added the difference in specific resistance, which is believed to be fair under the circumstances, the result for the largest filamentary burner is 27, and the smallest rod burner 1220; the smallest filament in the patent is worth 2,500 times the millimetre rod for the purpose of giving light commercially.

So far as the record has been investigated down to the present time, it would appear that Mr. Edison was entitled to a broad claim for the combination of a carbon burner, irrespective of its dimensions, with a vacuum chamber of this particular character. The real scope of his invention was broader than the filament, though that particular form was necessary in order to make it a practical success. The patent is limited to, or describes, that; but on the broader ground of his discovery of the stability of carbon, a liberal construction should be given to his claim.

At the last moment, defendent found that Dr. Isaac Adams had made what they call a lamp, having a carbon burner in such a chamber, years before Mr. Edison made this discovery and invention This was undoubtedly an absolutely abandoned experiment, and need not be dwelt upon. No sample has been preserved; no publication was made. A patent was applied for in 1882; a rejection was had upon Edison's patent; the rejection was accepted and the claims restricted. Whatever else it might have been, it was a lamp of large radiating surface and low resistance.

In conclusion, Mr. Dyer said that if he had succeeded in clearing away some obstructions in the line of sight, so that argument might henceforth be carried forward with less labor of both court and counsel, his duty would have been successfully performed.

Mr. Wetmore asked whether complainant claimed that the carbon filament of the second claim is one requiring a high resistance irrespective of its specific resistance. Mr. Dyer replied that it meant a carbon conductor of small cross-section and great tenuity. Its resistance depended upon its length, which might be longer or shorter. "That is to say," said Mr. Wetmore, "if a filament of great tenuity had only four ohms resistance it would fall within the claim." "I take it, your Honor," said Mr. Dyer, "that this is a discussion wholly irrelevant to this case. Here is the same attempt that was made with our witnesses." "I don't know about that," interposed his Honor, "The question has presented itself to my mind, and I would like to know if my understanding upon that point is correct." Mr. Lowrey said that complainant understood the claims to state explicitly what it was intended to claim. Infringement of the first claim would be claimed wherever there was a carbon filament of high resistance. Counsel had been retained to prosecute these three infringing lamps, but if a categorical question was asked as to whether a filament of four ohms was or was not within the second claim, his reply would be that he had not been retained to have an opinion on that subject, and did not know anybody who had. Mr. Wetmore said he did not think his question had been answered. It was a very important point in determining the construction of the second claim. Mr. Lowrey replied that all filaments relatively to their length had a high resistance, which Mr. Wetmore insisted was no answer at all. Complainant's counsel, he said, had drawn a broad distinction between conductors of low and of high resistance. He wanted to know whether that limitation applied to the second claim of the patent, because, neither from anything that had been said, nor from the record, nor from counsel's brief, had he been able to ascertain whether that claim was made or not . Mr. Lowrey said he should ask to have each of the three lamps in evidence convicted under both claims; with respect to the four ohm lamp, he was content to wait until the case arose. He was not instructed.

His Honor observed that the same question had arisen in his own mind, and he had found difficulty in answering it.

Mr. Lowrey said it was only when the facts were known that the difficulty was perceived of dealing with it except in an actual case. Mr. Wetmore contended that the claim ought to be explicit enough to answer so plain a question without reference to a particular case.

His Honor having intimated that he should like further information as to the difference between "series" and "multiple-arc" distribution, Mr. Lowrey gave a very clear and felicitous explanation of the matter, in which he was effectively aided by Mr. Dyer, after which the proceedings were adjourned for the day.

DECISION AGAINST THE NEW AMERICAN CO., ON DOUBLE CARBON LAMPS.

A decision was rendered in the United States Circuit Court by Judge Shipman, last week, in the suit of the Brush Electric Light Company against the New American Electric Arc Light Company to restrain the latter from using certain lamps, as they were an infringement upon Brush patents. In deciding for the Brush Company, Judge Shipman held that arc lamps in which two pairs of carbons are adjusted independently so as to burn successively were infringements upon the plaintiff's patents.

END OF THE EDISON LAMP SUIT ARGUMENTS.

The arguments in the infringement suit of the Edison Electric Light Company against the United States Electric Lighting Company were concluded before Judge Wallace in the United States Circuit Court, Thursday afternoon last, Mr. Dyer having been followed by Messrs. Seward and Lowrey on the Edison side and opposed by Messrs. Duncan, Wetmore and Betts, for the defence. The arguments attracted large audiences throughout. Judge Wallace said that he would announce his decision as soon as possible. He intimated that it was doubtful if he would announce it by July 1st, after which time an appeal would go to the Circuit Court of Appeals about to be organized. In the event of a decision before July 1st, an appeal would be heard in the United States Supreme Court. The models and exhibits will be sent to Syracuse, where Judge Wallace will examine them.

A DECISION IN FAVOR OF "EARTH RETURN" FOR ELECTRIC RAILWAYS.

The Supreme Court of Ohio, on June 2nd, rendered a decision, reversing the lower court in the case of the Cincinnati Incline Plane Railroad Company vs. the City and Suburban Telegraph Company, brought up on error to the Superior Court of Cincinnati. This involves the two great interests of telephone exchanges and electric street railways, and affects the city largely, as well as others adopting the improved and advanced system of street railways.

The action was brought by the telegraph or telephone company to enjoin the Incline Plane Railway Company from constructing and running their electric railway by the use of the Sprague, single trolley system, on the plea that the "earth return" interfered with the use of the telephone, and almost destroyed their business.

The telephone company claimed the first right to the earth, with the use of it for their return circuit. The matter could be remedied by one of two ways. First, by the railway putting in what is known as the double trolley system, by the use of which the telephone would not be interfered with. Second, by the telephone company, instead of using the earth for the return circuit, putting in "metallic circuits."

The finding of the court upholds the theory that the street is primarily intended for the use of the general public for the purpose of traveling and transporting goods, and the fact of motive power, which facilitates the object, being changed to something which might interfere with a subordinate use of the highway, ought not to make any difference in that regard.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 2, 1891.

Alarms and Signals :—

Electric Annunciator System, L. M. Pinolet, 453,416. Filed Sept. 25, 1890.
A system for hotels and other buildings. Instead of a separate drop or other indicator at the office or central point for each room or station the inventor employs a single indicating apparatus consisting of rotating concentric discs, adapted to display successively the desired numbers.

Circuit Closer for Burglar Alarms, E. A. Darling, 453,466. Filed Jan. 10, 1888.
A circuit closer adapted to be operated by the pressure of the foot when stepped upon.

Distribution :—

System of Electrical Distribution, F. A La Roche, 453,597. Filed May 17, 1890.
A system of parallel-circuit distribution. To avoid the fall of potential upon mains of considerable length, the inventor employs two generators of equal electromotive force, connecting the positive main at each end to the positive poles of the generators, and the negative lead, similarly, to the negative poles of the generators. The system is shown modified to include several generators similarly connected and distributed over a long circuit.

Dynamos and Motors :—

Electro Magnetic Engine, C. E. Kells, Jr., 453,260, Filed Feb. 24, 1891.
Employs an electro-magnetic clutch in series with the field-coils of a motor, and a circuit-breaker for stopping and starting the motor. Especially adapted for use with dental engines and similar machines.

Safety Device for Dynamos, C. G. Young, 453,281. Filed Mar. 31, 1890.
A device to effect the automatic opening of both out-going and in-coming circuits upon the occurrence of a ground upon either.

Automatic Switch for Electric Motors, R. McRae, 453,287. Filed Aug. 27, 1890.
A centrifugal governor adapted to control the speed of an electric motor.

Switch for Electric Motors, F. A. Wessel, 453,318. Filed Jan. 9, 1891.
An automatic rheostatic switch for regulating the speed of an electric motor.

Automatic Starting Switch for Electric Motors, F. A. Wessel, 453,319. Filed Jan. 9, 1891.
Similar to the next above.

Automatic Starting Switch for Electric Motors, F. A. Wessel, 453,320. Filed Jan. 9, 1891.
An automatic rheostatic switch controlling the admission of current to a motor.

Starting-Switch for Electric Motors, C. C. Haskins, 453,367. Filed Oct. 24, 1890.
A rheostatic switch, including a pivotal arm or finger controlled by a spring to return automatically to the off-point from any position.

Lamps and Appurtenances :—

Bracket for Electric Lamps, T. C. Smith, 453,248. Filed May 19, 1890.
A bracket especially adapted for supporting shunt-coils, converters, etc., and their connecting wires.

Detachable Rosette, C. E. Davis, 453,337. Filed Dec. 31, 1890.
A rosette fuse-block for use with pendant incandescent lamps.

Switch-Board for Electric-Arc-Light Stations, E. R. Sawyer, 453,349. Filed Oct. 23, 1890.
Details of construction and arrangement of circuits. A plug switch.

Electric Lamp Socket, Le R. S. White, 453,455. Filed Apr. 1, 1891.
Details of construction and method of securing the parts together.

Electric Arc Lamp, W. Hochhausen, 453,583. Filed May 28, 1890.
Relates to the feed regulation appliances, the transferring mechanism for double-carbon lamps, and to devices for suspending the lamps.

Medical and Surgical :—

Magneto-Electric Machine, W. Humans, 453,242. Filed July 23, 1885.
A machine for medical purposes.

Electrical Apparatus for Surgical Purposes, C. B. Harness, 453,476. Filed Jan. 26, 1891.
Apparatus for the treatment of patients preparatory to and during surgical or dental operations, and intended to diminish pain or render patients insensible.

Metallurgical :—

Method of Magnetic Separation, H. C. Townsend, 453,317. Filed Sep. 27, 1890.
Consists in establishing a flow or stream of liquid, such as water, in which the materials are carried in divided form, and producing in the stream two flowing strata, in one of which the magnetic material is retained by magnetic action opposed to gravity, and diverting the stratum containing the magnetic material through a channel separate from that through which the stratum holding the non-magnetic material passes.

Miscellaneous :—

Advertising Device, S. D. L. Jackson, 453,190. Filed Oct. 53, 1890.
An apparatus including a signal and a portable source of electricity.

Electric Connector, F. Wheeler, 453,225. Filed Dec. 30, 1890.
Designed to obtain an immediate and automatic separation when from any cause an unusual tension strain occurs.

Pole for Electric Wires, C. A. Lieb, 453,286. Filed Nov. 3, 1890.
Composed of metal strips or wire wound in a tapering spiral, the convolutions being united together, and a filling material within to reinforce the structure.

Electric Current Tester, W. H. Ebert, 453,323. Filed Feb. 20, 1891.
Provides a source of current for testing purposes consisting of a pair of electrodes adapted to be placed one over and one under the tongue.

Process of Coating Metals with Oxides, A. E. and A. G. Haswell, 453,363. Filed Nov. 3, 1890.
Process of electro-depositing binoxide of lead and binoxide of manganese on iron and steel. Consists in immersing the article to be coated in a bath containing nitrate of lead, nitrate of protoxide of manganese and nitrate of ammonia in solution, and in depositing binoxide of lead and binoxide of manganese by passing an electric current through the bath. First claim includes only the deposition of binoxide of lead.

Electrical Typewriting Machine, J. F. McLaughlin, 453,430. Filed Aug. 18, 1887.
Employs electro-magnetic apparatus for controlling the action of the letter-spacing pawl lever.

Electrical Register for Measuring Pumps, R. Jewell, 453,484. Filed June 20, 1890.
Especially adapted for registering the quantities of beer discharged from beer engines or pumps.

Automatic Electric Switch, R. Baumann, 453,572. Filed Nov. 7, 1890.
A cut-out adapted for use with heavy currents.

Railways and Appliances :—

Electric Street Car Motor, J. F. Shawhan, 453,216. Filed Sept. 9, 1889.
Consists of an electric motor having two independent revolving armatures, connected by gearing with independently revolving axles of the car. Shows a novel arrangement of gearing.

Insulating Cover for Trolley or Conducting Wires for Electric Railways, A. L. Ide, 453,326. Filed Dec. 31, 1890.
The trolley-wire is but partially enveloped by an insulating material. The insulation protects the upper surface of the conductor, leaving the lower surface exposed for contact with trolleys.

Railway Signaling Device, W. A. Luby, 453,447. Filed Nov. 26, 1890.
For signaling to a train on its approach to a station the condition of the track ahead of it or the dangerous or safe condition of switches. Acts automatically.

Electric Railroad-Signal Alarm, N. S. Chapman, 453,578. Filed Feb. 18, 1891.
Provides for an alarm to two trains approaching each other on the same track, for notifying the engineer of an open switch, and enables the engineer to test the batteries conveniently.

Telegraphs :—

Telegraph Receiver, C. Langdon-Davies, 453,261. Filed Nov. 18, 1890.
Relates to telegraph receivers for vibratory impulses and to the apparatus shown in the same inventor's patent Mar. 25, 1890, No. 424,006.

Sextuplex Telegraph, T. A. Edison, 453,601. Filed June 2, 1877.
At either end of a line one receiving magnet responds to reversals of current while the other two respond to an increase or to a decrease in the strength of the current independently of its direction.

Telephones and Apparatus :—

Holder for Telephone Receivers, F. T. and W. K. S. Tinning, 453,433. Filed Mar. 5, 1891.

Telephone Circuit, W. W. Jacques, 453,483. Filed Mar. 7, 1891.
Designed, with a given number of metallic circuits, to increase such number without adding additional wires and without changing the electrical conditions of the original circuits.

Telephone Transmitter, P. Fitzsimons, 453,581. Filed Sept. 9, 1890.
A carbon microphone.

Mechanical Telephone. J. P. Sunderland, 453,600. Filed Sept. 22, 1888.

LIGHTING THE HARLEM TUNNEL.

The State Railroad Commissioners have heard further statements and opinions as to lighting and ventilating the Harlem tunnel. Mr. W. J. Hammer advocated incandescent lighting. Mr. H. C. Ulman proposed arc lights concealed in the roof of the tunnel. Any use of lights was opposed by two of the locomotive engineers, who wished the only lights to be signals. L. J. Wing, representing the L. J. Wing Company, of No. 126 Liberty street, gave an interesting explanation of a plan to ventilate the tunnel. Mr. Wing's plan involved the closing of all the openings in the tunnel at both ends, except when a train is entering or leaving it, and proposes a system of rotary fans, continually exhausting the air from the tunnel and discharging it through three towers, the height of which, of course, could be made sufficient to prevent nuisance to people living along the line. Mr. Wing said the system was in successful use in the tunnel under the Mersey, in England, and in many collieries and other places.

NEW YORK SUBWAYS.

Mayor Grant threatens to forfeit the Subway Company's bond of $250,000, on the ground that it has not got its subways finished on time.

BID WANTED IN TEXAS.

Larmour & Watson, architects, Austin, Tex., want bids until noon of June 24, on an electric light plant for the Southwest Texas Insane Asylum. The plans and specifications can be seen at their office; also at the buildings, near San Antonio, Texas.

TRADE NOTES AND NOVELTIES

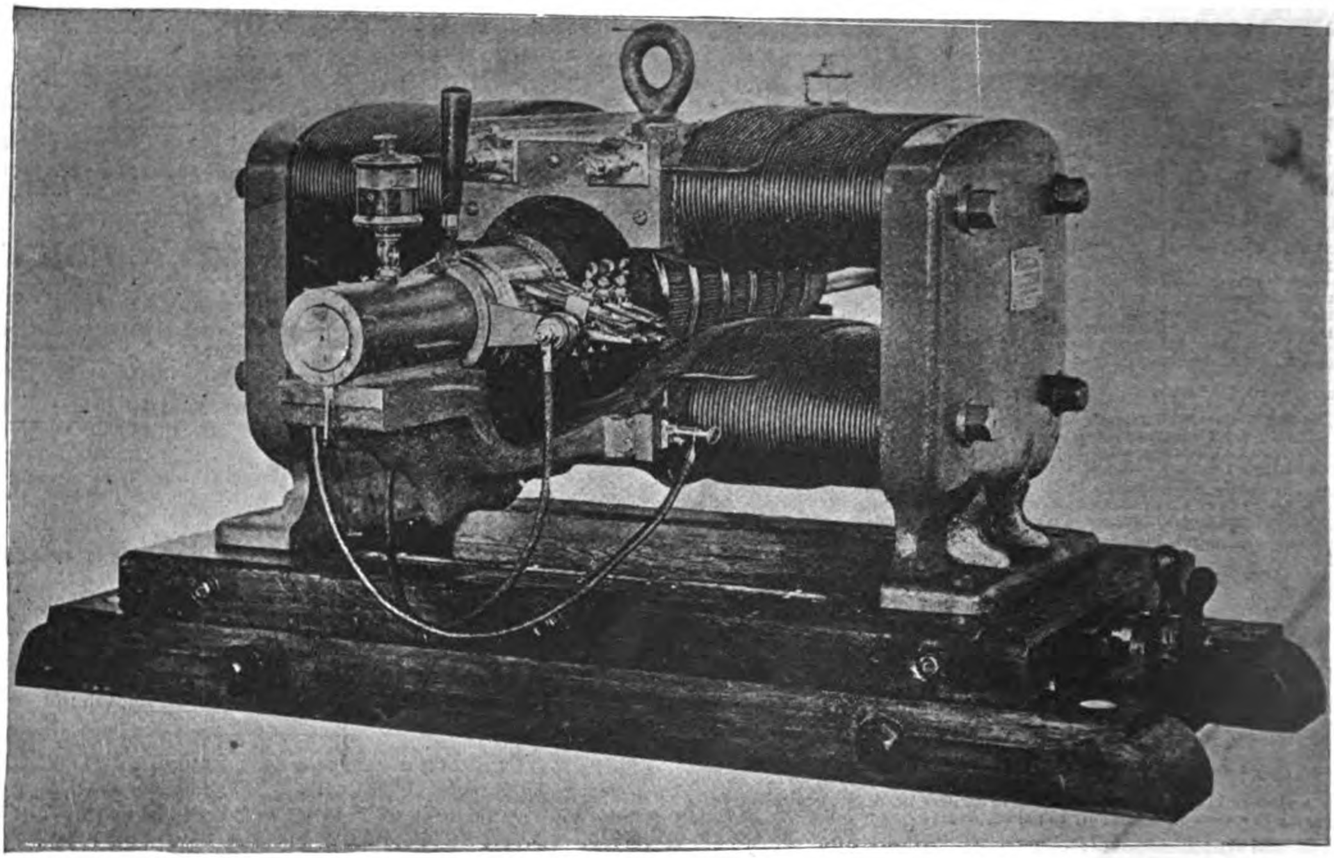
AND MECHANICAL DEPARTMENT.

Don't be afraid to let people know you are in business.

THE FONTAINE DYNAMO.

THE accompanying illustration represents the dynamo manufactured by the Fontaine Crossing Co., of Detroit, Mich. These machines are especially adapted to use in mills, shops, factories, and steamships. They are entirely self-regulating, and especial attention has been given to the mechanical construction of the working parts, with smooth running and high efficiency as the result.

One of these dynamos is now on board the "E. C. Pope," the largest freight steamer on Lake Michigan, operating the equivalent of 225 16 c. p. lamps, at a speed of only 450 revolutions, and is running smoothly and noiselessly.



THE FONTAINE DYNAMO.

These dynamos are shunt and compound wound, with drum armatures, of very low resistance, and run at a very slow speed, beside possessing the other points inherent in good machines.

LIGHTING THE WORLD'S FAIR WORK.

Prof. John P. Barrett of the Department of Electricity of the World's Columbian Exposition, has visited Jackson Park with a view to selecting a suitable location for establishing an electric light plant, during the period of construction. He considers that the proper and most desirable place for this station, is on the west side of the park, opposite 63rd street, and the probable cost will entail an expenditure of some $20,000, and in the neighborhood of 200 arc lamps will be required for the work.

ELECTRICAL FIBRE CARBON CO.

The above concern, of 1234 & 1236 Michigan avenue, Detroit, Mich., are now in the field manufacturing improved galvanic batteries, and they claim to have the best and most economical form now on the market. They say, "Its construction is excellent for a wet battery. It is self-contained. There is no creeping of salt, no breakage of glass jars, no attention needed after filling with water, while its best quality is that of outwearing any other battery of its sizes that cost twice as much money." Their factory is well equipped for the manufacture of superior carbon elements, and under their patents they make extra large carbons. In fact, their methods and processes enable them to mould carbon elements, "into any size that iron castings have ever been produced in." The company is strongly organized, having John R. Markel as president, J. H. Davis as vice-president, and Eugene Klein as secretary and treasurer.

PARTRICK & CARTER CO.'S CANADIAN AGENCY.

The above enterprising Philadelphia house have made arrangements with the Toronto Construction & Electrical Supply Co., of Toronto, Can., for a general Canadian agency, which will carry in stock a full supply of their annunciators, alarms, bells, pushes, batteries, etc. This arrangement has been made for the convenience of the trade in general, and will enable a great many, who have desired to use the Partrick & Carter specialties more extensively, to do so, free from the delays of transit and the heavy charges of transportation. The prices will be very nearly those of Philadelphia, any difference being practically offset by the saving in time, freight charges, breakage, etc.

THE MILLIKEN COMBINATION POLE.

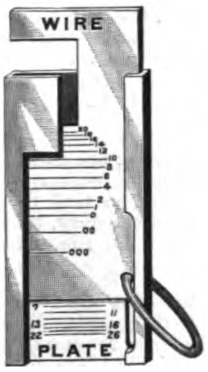
Messrs. Milliken Bros., New York City and Chicago, report a large increase and demand for their patent poles for electric street railway and electric light use. They have lately booked orders for a large number of poles for the Pittsfield Electric Light Co., a new form of combination pole for both street railway and electric light wires. They have also received orders for Los Angeles, Cal.; Little Rock, Ark.; St. Louis; Plainfield, N. J., and Brooklyn. Parties in Wilmington, Del., have found it to their advantage to use poles somewhat similar to the large poles which this concern lately furnished to Passaic, N. J., and which are known as the largest street railway poles in the world. The arms for these poles are only a trifle shorter than the poles supplied to Passaic. Those who desire a first-class pole for street railway work cannot do better than write these parties for their handsomely illustrated catalogue, which gives full information. They are furnishing a large number of poles to South American countries, and report business very brisk.

THE CENTRAL ELECTRIC CO.

As an indication that electrical construction is beginning to pick up in earnest, the Central Electric Company report a largely increased demand for soldering torches of various kinds. This company carries a large assortment of these goods and handle all the most approved styles.

The Bain "break" insulator, handled by the Central Electric Company, is having a ready sale, and is fast growing in popularity with electric railroad men, who use it for insulating span wires. The electric light companies are also ordering them in considerable quantities to insulate suspended arc lamps.

A NOVEL WIRE AND PLATE GAUGE.

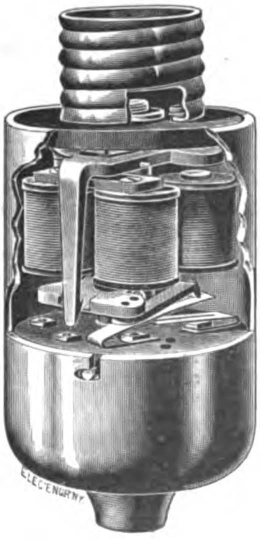


A VERY useful and ingenious little contrivance is the wire and plate gauge shown, full size, in the accompanying illustration. It is intended to be carried on a key ring, and is instantaneous in action, simple in construction, and can neither get out of order readily, nor become inexact. The wire and plate numbers are shown on one side, and on the other appear the diameters in fractions of an inch. The instrument is made of polished steel, and is manufactured by the Rush & Gildemeyer Mfg. Co., 1004 Walnut St., Philadelphia.

DIXON'S GRAPHITE GREASE.

A large manufacturer of steam, hydraulic and hand elevators in Baltimore writes that they have been using Dixon's Graphite grease on their elevators for about two years, and find it superior to any lubricant they have ever used. They also use it on their wire cables to prevent rust, and for the guides of elevators. It is made by the Jos. Dixon Crucible Co., of Jersey City, N. Y.

THE ROUSSEAU AUTOMATIC SOCKET SWITCH.



ROUSSEAU'S AUTOMATIC SOCKET SWITCH.

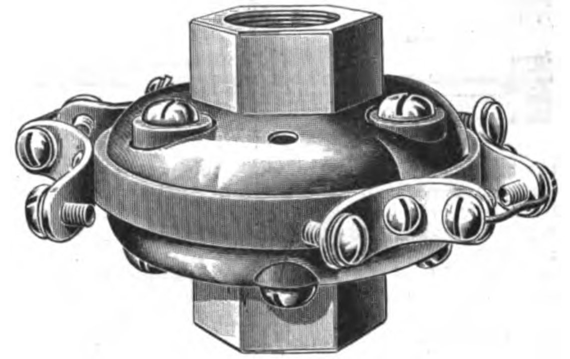
It is frequently desirable to light and extinguish lamps from a distance, and a convenient method of accomplishing this without running heavy wires will find many applications. To accomplish this in a simple manner, the well-known method of employing a pair of push buttons has recently been applied for switching on and off an incandescent lamp, much in the same manner as in connection with automatic gas burners.

The accompanying illustration shows the device as constructed by Mr. D. Rousseau, of this city. As will be seen, the switch of the lamp contains two pairs of electro-magnets, each pair in circuit with a push button. In the position shown, the switch contacts, consisting of two blades of spring copper, are out of contact. By pressing the "lighting" button, the lower armature is attracted and raised, while the arm attached to it presses the springs into contact and thus closes the circuit to the lamp, which lights. The armature thus raised is maintained in position by engaging with a latch attached by an arm to the upper armature.

To extinguish the lamp the other button is pressed, which attracts the upper armature and trips the latch, allowing the lower armature to fall and the springs to break contact. The device is evidently very simple in its nature and can be readily attached to any lamp. It thus enables a lamp to be controlled at any distance by a very fine auxiliary wire without the necessity of carrying the lamp circuit out of its direct course.

STAR ELECTRIX COMBINATION CUT-OUT AND INSULATING JOINT.

THE accompanying engraving illustrates a new device manufactured by the Star Electrix Co., of Philadelphia, consisting of an insulating joint of a particularly strong and convenient type, to which is added a neatly arranged, double-pole cut-out device.



STAR ELECTRIX COMBINATION CUT-OUT AND INSULATING JOINT.

By the use of this combination joint, a separate cut-out at the fixture is dispensed with, and the whole arrangement is covered by the canopy of the fixture. The construction is such that without the brass clips and fuse, it can be used as the ordinary insulating joint.

PHILADELPHIA NOTES.

THE WASHINGTON ELECTRIC CONDUIT CO. are laying five miles of their patent glazed terra-cotta conduit in the city of Washington, D. C. This conduit is being extensively used in the cities of Chicago, Cleveland, Milwaukee and Baltimore.

MR. J. W. PARKER, Philadelphia agent for the Ball Engine Co., has sold a 150 h. p. special railway Ball engine to the Allentown, Pa., Electric Railway Co.; also a 150 h. p. tandem compound special railway engine to the Lebanon, Pa., Electric Light Company.

MR. B. FRANK JOHNSON, general agent for the Interior Conduit and Insulation Co., has contracted, through the Edison General Electric Co., to equip throughout the new Chamberlin Hotel, at Old Point Comfort, with interior conduits.

MR. HENRY B. CUTTER has just installed a 35 Station Eco Magneto watchman's clock system at John B. Stetson's hat factory; also a 35 station clock at the Penn Mutual Building, 925 Chestnut street.

MESSRS. W. H. WESTON & CO., switch manufacturers, are adding more room and new machinery to their factory whereby they will triple their present capacity.

NEW YORK NOTES.

THE "ACME LINK" AND "EUREKA DYNAMO" belts, made by the Page Belting Co., 16 Dey street, New York, are meeting with remarkable success for power transmission in electric lighting and street railway stations. The principles embodied in these belts show greater traction power and strength compared with belts of old style as heretofore constructed. Among recent orders filled by this company was one for the Hampton and Old Point Comfort R. R., at Hampton, Va., where two 20″ wide "Acme" link and several "Eureka Dynamo" belts are running, the superintendent says, "as nicely as any thing I've ever seen."

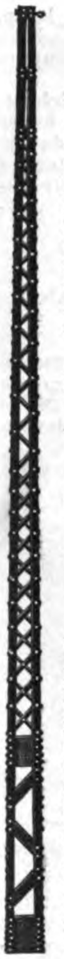
MR. F. SAXELBY will join the forces of Mr. Shain in the Eastern district of the Edison General Co., and while acting as salesman for all the products of the company, will make a specialty of lamps, with which he has had a long experience in their manufacture.

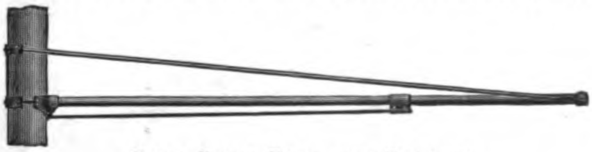
GILES STEEL RAILWAY POLES AND BRACKETS.

THE Giles steel railway pole is made up of four angle sections, forming the four corners of a square, and to resist the pull of the span wire is a simple matter of making these angles of sufficient size and weight to furnish the required cross section. The pole being square, offers as much resistance to pull in one direction as another. At the grade line where the chief trouble has been with many other poles we separate the angles by two large plates. These poles can be set to pull against a stone or other solid packing at this point without danger of crushing. The design of the pole and light, tapering evenly from the ground up and as it is latticed and open it does not present as clumsy an appearance as a solid pole.

In addition to the above points the pole is especially designed for the heavy strains met with in double track and curve work.

The Giles steel railway bracket is of the best lap or butt-welded steel tube held in place against the lower plate of the bracket by a wrought iron clip rivetted to same. This plate is clamped to the pole, no screws or spikes being necessary and is of such size and shape as will allow of ready attachment to poles of different diameters. The load is directly supported by two truss rods of steel, which pass on either side of the pole and are attached to a heavy bar or plate. They are provided with thread or nut, by means of which the height of the arm is adjusted. A smaller rod is run on the under side of the arm, which prevents raising of same by the passing under of the trolley. It is claimed that this is a rigid bracket, free from swaying motion, lifting, or springing and vastly superior to those made wholly or in part of cast iron. They are made of first-class materials in a first-class manner and are fully guaranteed. The above are handled in the West exclusively by the Illinois Electric Material Company, 158 Fifth Avenue, Chicago.

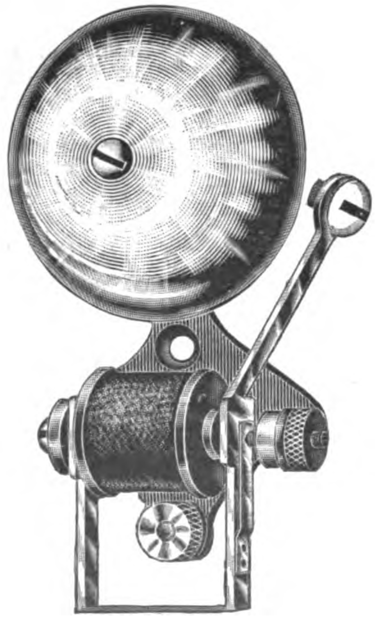




GILES STEEL POLE AND BRACKET.

THE HAY-HORN BELL.

THE accompanying illustration represents the new bell manufactured by Hay-Horn Mfg. Co., of Chicago. This bell is not only attracting attention in this country, but is being used extensively abroad, wherever samples have been tested. The object of the manufacturers in making this style of bell is not only to reduce the cost nearly one-half, but also to give loudness of tone with a small battery current.



THE HAY-HORN BELL.

Much time is generally required in adjusting the hammer of a bell so as to produce the best results, but the manufacturers have overcome this difficulty by introducing an adjustable hammer, enabling one to set it right very quickly. The bell is well made and finished, having platinum contacts and is tested on a circuit of 200 feet, using only one cell of battery.

The Eastern agent of the company is Mr. Jas. H. Mason, 118 Park avenue, Brooklyn.

WESTERN TRADE NOTES.

THE FLETCHER & FLETCHER ELECTRIC CO., 1315 St. Water street, Cleveland, Ohio, are enjoying a boom in their electrical supply business, and are filling orders for their specialties and novelties in all parts of the world. This is a highly encouraging state of affairs, and it is also interesting to note that the outlook was never better.

M. C. CHASE, 43 to 45 S. Canal street, Chicago, the well-known manufacturer of hard rubber goods, is doing an active and increasing business, and reports orders as coming in in a very brisk manner. He manufactures all kinds of articles of hard rubber, and his battery cells and other specialties are widely known and used.

ANDERSON & JOHNSON, 46 S. Canal street, Chicago, are making a large number of their disc exhaust fans, and have recently received orders for a very large amount of business, so that they are running their factory to the full limit of its capacity, to be ready for a heavy demand for their fans which, with the warm season, is now upon them.

WILLIAM BARAGWANATH & SON are constructing a large number of their well-known feed water heaters of various sizes. These are known in electric power and light stations all over the country, for their strength, durability, and thoroughly reliable operations.

THE ELECTRICAL ENGINEERING CO., who are handling the Standard dynamos and the Perret motors, are meeting with large success in the introduction of both of these well-known machines. They are also contractors for the complete equipment of electric light and power plants, and doing a flourishing and prosperous business.

THE GREAT WESTERN SUPPLY CO. report that their new catalogue of railway supplies is now in the printer's hands and will be ready in about two weeks. It will be very complete, covering all the standard appliances required in the construction of electric railway lines, of the different systems, and in addition, all their own specialties.

THE ELECTRIC MERCHANDISE CO., of Chicago, has issued birthday cards celebrating its first anniversary under its present management. It has had a brilliant career, not due to luck, but the outcome solely of hard work and sound judgment in meeting the demands of a new industry.

THE ELECTRICAL SUPPLY CO. has put on the market a line of aluminum shades for incandescent lamps. They are spun in one piece, and can be had frosted or in mottle finish, and bright satin finish inside. They do not tarnish, and can be cleaned by simply wiping them off with a damp cloth or chamois.

THE THOMSON-HOUSTON ELECTRIC CO. reports the following recent sales made through its Western isolated lighting department: Smith Steam Baking Co., Kansas City, Mo., 50 light incandescent plant; Wainwright Real Estate Co., St. Louis, Mo., 3,000 incandescent lights; Iowa Agricultural College, Ames, Ia., 6 arc light dynamo, 35 light incandescent dynamo, one 1. h. p. motor, and appurtenances for laboratory use; Cudahy Packing Co., Sheffield & North aves., Chicago, 125 incandescent lights; Carson, Pirie, Scott & Co., Adams & Franklin streets, Chicago, 35 arc light and 400 light incandescent plants; S. S. Badger, Ouray, Col., 100 incandescent light plant; Central Market Co., State & South Water streets, Chicago, 18 arc light plant and 200 light incandescent plant; Chicago City Railway Co.. 150 light incandescent plant; H. H. Shufeldt & Co., 23 Larabee street, Chicago; 250 light incondescent dynamo to increase capacity of plant sold last November.

THE EMERSON ELECTRIC MANUFACTURING CO., of St. Louis, has issued a neat circular relative to its new Weston alternating current motor, recently illustrated and described in THE ELECTRICAL ENGINEER.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XI. JUNE 17, 1891. No. 163.

PINOLET'S ANNUNCIATOR SYSTEM.

IN the hotel and house annunciators at present employed, it is necessary after a call has been noted to reset the drop by hand, and when this is not done immediately a second or third drop may fall and thus make it impossible to know whether the first call has been repeated. It is therefore necessary that the attendant be constantly engaged in resetting the drops, so as to avoid confusion. Again, the bell usually sounded at the time the drop falls, rings only for an instant, and frequently fails to attract the attention of the clerk, who is usually engaged in other duties at the hotel desk. To obviate both these difficulties, Mr. Louis M. Pinolet, of Brooklyn, N. Y., has devised an ingenious annunciator system, without adding any additional complications, or increasing the amount of wiring necessary about the building.

The accompanying engravings, Figs. 1, 2 and 3, show the annunciator in plan, and two sectional views, respectively, and Fig. 4 is a diagram of the circuits employed.

It will be noted that digits are marked upon concentric transparent dics, *m'* and *m*, which are rotated by a pawl and ratchet electric motor, and that each disc stops independently of the other at the proper place to give an indication. The means for stopping any given disc, consists of an armature *r* adapted to be attracted into the path of a projection *p*, *p'* or *o*, *o'* upon the disc.

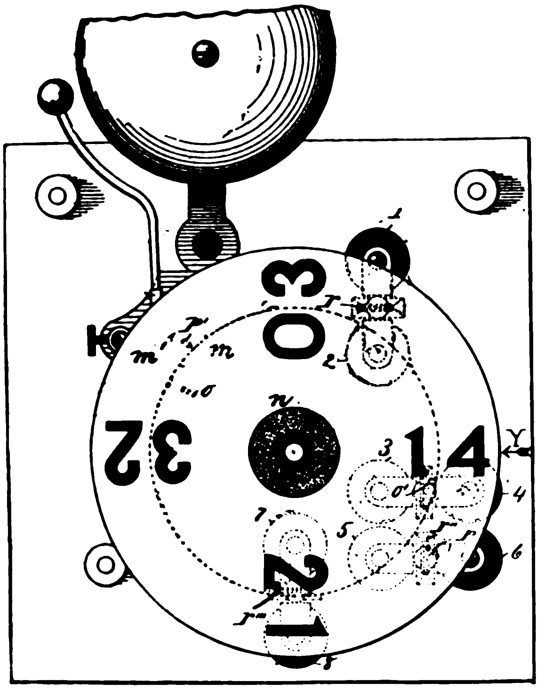
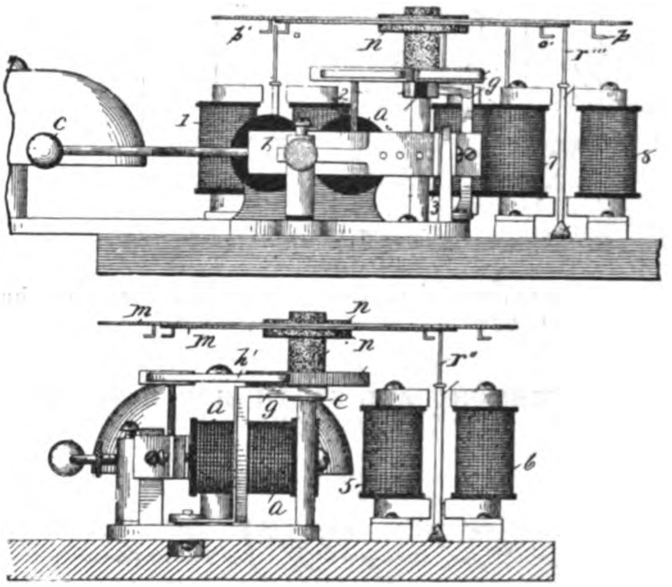


FIG. 1.—PINOLET'S ANNUNCIATOR SYSTEM.

The magnets for attracting the armatures are arranged at proper distances around the axis of the discs, which rotate, when the motor is in operation, on account of the friction between them and washers *n* on the motor, until one of the discs is stopped by an attracted armature. The motor continues to turn the other disc until it is likewise stopped, and then continues its motion until the ratchet wheel has made a complete rotation. In the engraving these magnets are the smaller ones, while the single large magnet *a* is for operating the bell and motor.

When a push button *v*, in any room, is pressed, a current passes through the bell magnet, whose armature vibrates in the usual manner, and rotates the ratchet wheel of the motor, the arbor of which carries a piece of insulation normally in contact with the brush *g*. By the time the pressure is removed from the push button, the insulation has left the brush, thereby closing a local circuit which rings the bell until the insulation has passed around once, when it interrupts the local circuit, and the bell ceases to operate. At the same time in which the button is pressed, one of the magnets 1, 2, 5, 6 and one of 3, 4, 7, 8 are included in the circuit, and attract their armatures, which must evidently be held until the motor stops. For this reason, these magnets are introduced into the local circuit by means of circuit closers which make contact with the attracted armatures.



FIGS. 2 AND 3.—PINOLET'S ANNUNCIATOR SYSTEM.

It is quite surprising to notice in the operation of the device, that instantly removing the finger from the button that has been pressed, does not prevent the working of the instrument, the time occupied in indicating a number being two or three seconds, while the bell rings for six or seven seconds.

As the indicating numbers are formed by the combination of the digits on one disc with those on the other, it is evident that the number of signals which can be given is equal to the product of the digits on one disc by those on the other, thus requiring fewer magnets and rendering the construction proportionally simpler than that of an ordinary annunciator. For example, if a hotel has 50 rooms, its annunciator would have only 15 magnets, besides the bell magnet, there being five digits on one disc and ten on the other. It is a peculiar property of the device that it requires no setting, the last indication remaining till another is given. In practice, the instrument has a face plate with an opening opposite the arrow Y for the appearance of the indicating number.

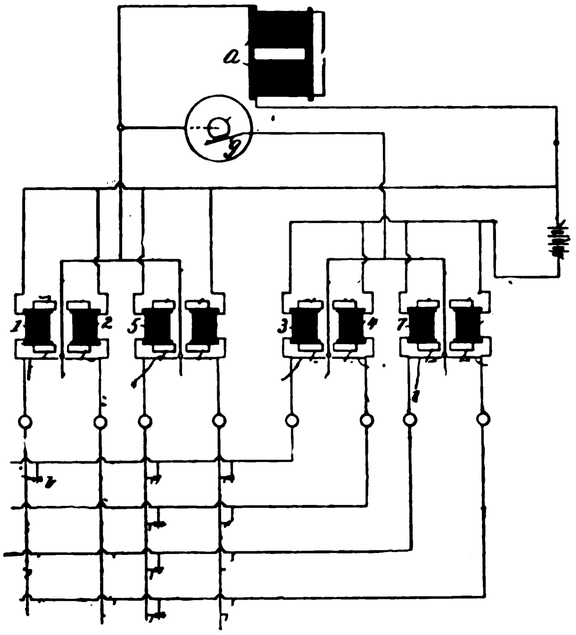


FIG. 4—PINOLET'S ANNUNCIATOR SYSTEM.

THE RICHMOND AND SOUTH SIDE ELECTRIC RAILWAY.

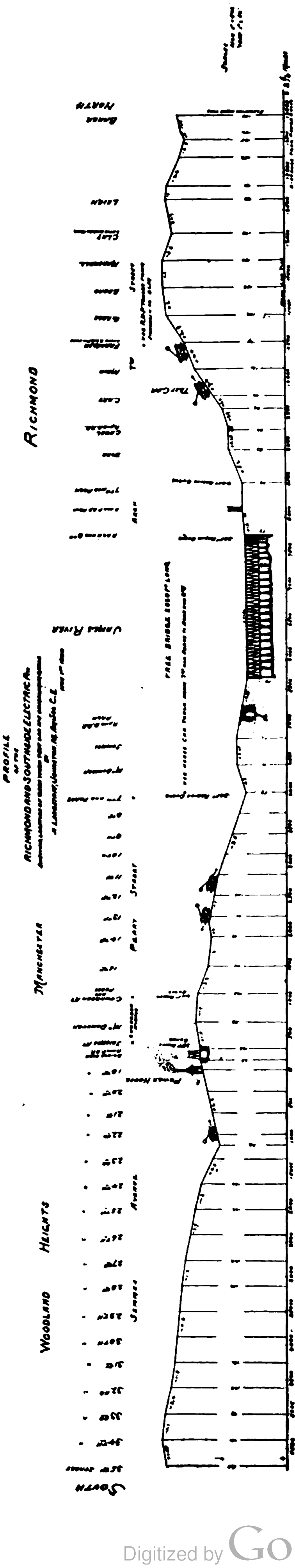
BY

A. Langstaff Johnston

IMMEDIATELY upon the completion of the Richmond and South Side Electric Railway, at Richmond, Va., in October, 1890, the usual tests with the voltmeter and ammeter were made on one car; at the same time the locations of the other four cars (there are five) were taken by observers on them, so that their positions were known when the test car was upon the maximum grade which is $7\frac{4}{10}$ per cent. The tracks were new, curves unworn, and equipment stiff.

The accompanying profile shows the rate and frequency of the grades and curves, the minimum of the latter being 30 foot radius. The accompanying table, in connection with the profile, explains fully the test. The length of the road is four and a half ($4\frac{1}{2}$) miles; although the test was made on $3\frac{7}{10}$ miles only. The road is double track, laid with the following kinds of rails: From the northern terminus to 7th and Clay streets, 45 lb. side bearing steel tram rail; at this point it connects with and passes over the Union Passenger Railway (the first electric railway built here, and on which the Sprague motor was developed) for four blocks to 7th and Franklin streets. From this point to Free Bridge is laid with a 50 lb. steel grooved rail on a 5"x8" pine stringer.

At the Free Bridge connection is made with the Manchester horse car tracks, belonging to the Richmond and South Side Railway; these tracks are 45 lb. iron side bearing tram rails which were bonded on the bridge for the electric road. From the south end of the bridge to 7th and Perry streets, 35 lb. Johnson girder rail was used, which had to be strengthened and trussed before it would



PROFILE OF THE RICHMOND AND SOUTHSIDE ELECTRIC RAILWAY, WITH CARS IN OPERATION AT DIFFERENT POINTS.

stand the traffic of electric cars. From 7th and Perry streets to Woodland Heights 30 lb. T-rail, on cross ties, is used.

The equipment consists of five 16 ft. vestibule Brill cars, with two 15 h. p. Sprague-Edison motors. At the time of test, current was furnished by one 80,000 watt Edison dynamo, driven by a 100 h. p. Ball engine. The gearing employed on the motors is Atwood's noiseless wooden tooth, which gives great satisfaction. The table shows in a striking manner the increase of power required at curves and grades and also the influence of the type of rail employed.

RECORD OF A TEST MADE OVER THE LINE OF THE RICHMOND AND SOUTHSIDE ELECTRIC RAILWAY, BY A. LANGSTAFF JOHNSTON, C. E. CHIEF ENGINEER, NOV. 1ST, 1890.

Instruments placed on Car No. 5, and Car run over the east track from the south end at 34th street and Semmes avenue, Woodland Heights, to 7th and Baker street, Richmond.

NORTH TRIP.

Time taken on test car. P. M.	Location of Car on line.	Weight of car and passengers, lbs. est.	Rate of grade per cent.	Length of grade.	Distance of test car from power house at time readings were taken.—(Feet.)	Kind of rail passed over.	Reading of meters on car.		Reading of meters at power house.		H. P. delivered at power house.	H. P. developed by motors in moving car.	Drop in voltage on line.	Radius of inside rail of curve.	Remarks.
							Amp.	Volt.	Amp.	Volt.					
5.45	34th and Semmes av.	8000	+1.5	310	5500	T	20	460	60	480	38.6	12.3	30		Grades opposed to car going
5.50	Semmes av. bet. power house & 22d st.	"	+2.3	1000	1000	"	20	460	80	"	51.5	12.3	20		north, marked thus +
5.53	Curves at Semmes av. bridge........	"			300	"	45	480		"		28.9	00	35′	
5.54	Curve at Cowardin and Perry...... ...	"			1100	"	30	460		"		18.5	20	49′	Grades opposed to car going
5.55	15th and Perry, Pass No. 2....	8200			1500	"			80	"	51.5				south, marked thus —
6.	Curve at Perry and 7th....	"			4000	"	40	460	20	"	12.9	24.6	20	39′	
6.01	On 7th, bet. Perry and McDonough...	"	+3.	360	4200	Tram	30	480				19.3	00		Grades are given in feet per
6.03	S. end free bridge, Pass No. 3....	"			5600	"									100 (per cent. %).
6.05	On free bridge		0.0		6500	"	10	445	100	"	64.3	5.9	35		
6.06	Curve at 9th and Arch................				7700	"	40	460				24.6	20	39′	Each car equipped with two
	Curve at 7th and Arch....				8500	"	40	400				21.4	80	40′	30 h. p. motors (Sprague).
	7th bet. Arch and Byrd................		+5.2	300	8700	Small grove	20	440				11.7	40		
6.10	7th bet. Main and Cary...............		+7.4	300	9800	"	40	440	90	"	57.9	23.5	40		Maximum grade.
	7th bet. Franklin and Main...........		+2.0	300	10400	"	15	444				8.9	36		
	7th bet. Franklin and Grace...........	8000	+6.9	300	10800	Tram R. U. P.	25	400				13.4	80		Richmond Union Pass
6.15	7th and Marshall.....................	"			11700	"		440	80	"	51.5		40		Track.
	7th bet. Clay and Leigh...............	"	+1.7	400	12400	Tram	20	420				11.2	60		

The road has now been in operation for seven months. The electrical repairs have been so remarkably low that the management considers them almost nothing.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—III.

BY

Chas. Steinmetz.

Now this secondary M. M. F., l_1 combines with the (still unknown) M. M. F., L, of the primary current to the resulting M. M. F., $F = 2{,}400$ ampere turns. But the combination of sine waves in their polar co-ordinate system follows the fundamental law of the *parallelogram* of forces, that is, Fig. 4:

"Any two sine waves, in phase and intensity (amplitude) represented in polar co-ordinates by straight lines, $\overline{OB}$, $\overline{OC}$, *combine to a resulting wave* $\overline{OD}$, *which, in its phase and intensity, is represented by the diagonal of the parallelogram, which has the two component waves* $\overline{OB}$ *and* $\overline{OC}$ *as sides."*

For, in Fig. 4, the (algebraic) sum of the two projections $\overline{ob}$ and $\overline{oc}$ of the component waves, $\overline{OB}$ and $\overline{OC}$ upon any radius, $\overline{ox}$ is equal to the projection $\overline{od}$ of the resulting wave, $\overline{OD}$ upon $\overline{ox}$, because $\overline{oc} = \overline{bd}$.

From this follows directly the *law of the polygon of sine-waves.* This, or rather a similar form of a parallelogram law for sine waves, has been used before by Kapp, Blakesley and others, but, I hardly think, with a full appreciation of its convenience in dealing with alternate current phenomena.

In reality, the parallelogram law is nothing but the geometrical formulation of the *law of conservation of energy.* Hence the parallelogram law appears in combining velocities, accelerations, forces, rotary movements, electric and magnetic waves, etc.

At the same time this law, together with the fact, that all the differential and integral functions of sine functions are sine functions again, gives the proof that, if the primary E. M. F. of the transformer is a sine wave, all the other electric and magnetic quantities are sine waves also.[1]

By using this parallelogram law, we now get the primary M. M. F.,

$$\overline{OL} = L, \text{ Figs. 2 and 3,}$$

as the second side of a parallelogram, of which the *secondary* M. M. F., $\overline{OL_1}$ is one side, the *resulting* M. M. F., $\overline{OF}$ the diagonal.

In Fig. 3, we have practically the same diagram as in Fig. 2, repeated, except that the circles are left out, because they are needed only when dealing with the instantaneous values of the electric and magnetic quantities; while, when only considering their mutual combinations and correlations, these sine waves may be represented in phase and strength (amplitude) by their maximum values, as shown in Fig. 3.

Measuring $\overline{OL}$ in the parallelogram, OL_1, FL, we get the *primary* M. M. F. determined by:

$$\overline{OL} = 1.152 \text{ inch,}$$

$$\text{angle } AOL = \varphi = 38.7 \text{ degrees.}$$

---

[1] *Hysteresis* will be treated of later on.

Hence the maximum M. M. F. of the primary current is :

$$L = 3{,}840 \text{ ampere turns,}$$

since 1 ampere turn = .0003 inch,
and occurs at an angle of : $\varphi = 38.7$ degrees,
that is, at the time,

$$t = \varphi \frac{T}{2\pi} = .0008 \text{ second,}$$

after the zero value of the resulting M. M. F., F.

The circle with $\overline{oL} = 1.152$ inch as a diameter, cuts out on any ray $\overline{ox}$ (Fig. 2), the instantaneous value of the primary M. M. F., for instance for $t = \frac{T}{6}$, $\vartheta = 60°$;

$$\overline{o\,l} = 1.072 \text{ inch} = 3{,}576 \text{ ampere turns.}$$

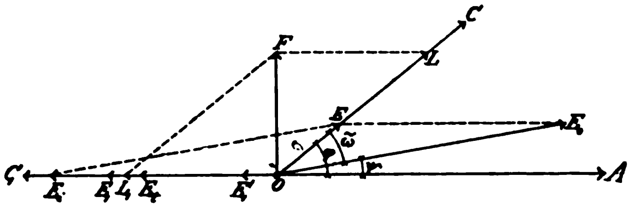


FIG. 3.

The number of primary turns being $n = 80$, the maximum value of the *primary current* is :

$$C = \frac{L}{n} = 48 \text{ amperes ;}$$

hence its *effective value* is :

$$\frac{C}{\sqrt{2}} = 34 \text{ amperes effective.}^1$$

This primary current being represented by the circle having $\overline{o\,c} = 1.44$ inch,

as a diameter, gives for the time, $t = \frac{T}{6}$, the instantaneous value : $\overline{o\,c} = 1.34$ inch = 44.7 amperes.

Let the *resistance of the primary circuit* $R = 1$ ohm ; then the *resulting or heating* E. M. F., that is, that E. M. F., which is consumed by forcing the primary current through the primary resistance, is :

$E = C \times R = 48$ volts, and is equiphased with the primary current.

Therefore it is represented in the diagram, Fig. 2, by the circle with $\overline{o\,E} = .48$ inch as a diameter.

Now this E. M. F., E, is the *resultant* of the *impressed primary* E. M. F. (terminal-pressure, E. M. F. of the dynamo-generator, or potential difference between those two points of the primary circuit, between which the resistance $R =$ 1 ohm), and the E. M. F. *induced* in the primary coil of the transformer by its varying magnetism.

This *induced primary* E. M. F. has the maximum value :

$$E_1 = \frac{2\,\pi\,n\,M}{T} = \frac{n}{n_1}\,E_1 = 133 \text{ volts,}$$

at the same time as the induced secondary E. M. F., E_1 ; that is, at the time $t = \frac{T}{2}$, or the angle, $\vartheta = 180°$. Hence it is represented by a circle with $\overline{o\,E_1} = 1.33$ inch as a diameter.

From the *resulting* E. M. F., E, and the *induced primary* E. M. F., E_1, we derive the *impressed primary* E. M. F., E_0 by the parallelogram of sine waves.

The *resulting* E. M. F., E, is the *diagonal* of the parallelogram, the two *sides* of which are the *induced* E. M. F., E_1, and the *impressed* E. M. F., E_0. This parallelogram, $o\,E\,E\,E_0$ gives :

$\overline{o\,E_0} = 1.73$ inch, that is : $E_0 = 173$ volts as the *maximum impressed primary* E. M. F., which occurs at an angle $A\,o\,E_0 = \psi = 10.0$ degrees :
that is, at the time $t = .0002$ seconds.

Hence the *effective value of the impressed primary* E. M. F. is :

$$\frac{E_0}{\sqrt{2}} = 122 \text{ volts effective,}$$

and the *shifting of phase* between primary current and impressed E. M. F.:
angle $\omega = \varphi - \psi = 28.7$ degrees, or about .0006 second.

At the time, $t = \frac{T}{6}$, the impressed primary E. M. F. has the instantaneous value :

$$e_0 = \overline{O\,e_0} = 1.11 \text{ inch} = 111 \text{ volts.}$$

The difference of phase between impressed primary E. M. F., and secondary E. M. F. is, angle $180 - \psi = 170°$.

Between primary and secondary current, angle $180 - \varphi = 141.3°$.[1]

Quite frequently the size of the primary E. M. F. and of the secondary E. M. F. in commercial transformers is so different, that we are obliged to use different scales for the primary and for the secondary circuit. For instance in a transformer, which yields 100 volts in the secondary circuit, when the primary coil is fed by 1,000 volts, we may represent.

In the *secondary* circuit :

1 volt = .01 inch.	1 ampere = .03 inch.

In the *primary* circuit :

1 volt = .001 inch.	1 ampere = .3 inch.

M. M. F. and effect are always represented in the same scale in both circuits.

Let $R_1 = .4$ ohm be the internal resistance of the secondary circuit, then the maximum *drop of potential in the secondary* for full load is :

$$E_1^{\,1} = R_1 \times C_1 = .4 \times 50 = 20 \text{ volts,}$$

represented by the circle over, with $\overline{o\,E^1_1} = .2$ inch as a diameter.

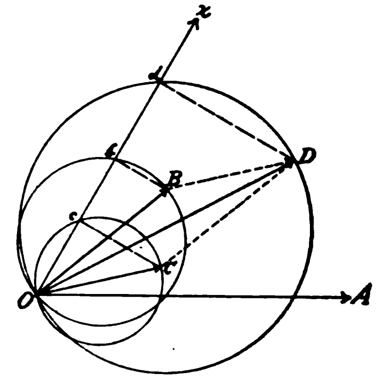


FIG. 4.

The *maximum terminal pressure of the secondary* for full load is :

$E_1 = E_1 - E_1^{\,1} = 100 - 20 = 80$ volts, and is represented by the circle, with

$\overline{o\,E_1} = .8$ inch as a diameter. Hence its *effective value* is:

$$\frac{E_1}{\sqrt{2}} = 56.5 \text{ volts effective.}$$

It is of interest to note, that primary current and secondary current are most of the time flowing in opposite direc-

---

1. This figure is considerably larger than : $\frac{n_1}{n}\,C_{1\,\text{eff.}} = \frac{60}{80} \times 35.35 = 26.5$ amperes, assumed in the first approximation ; but only because of the very unfavorable constants chosen ; in reality the primary current for full load is very nearly $\frac{n_1}{n}\,C_1$ in good transformers, so that for laying out the size of the wires it can be assumed as equal to $\frac{n_1}{n}\,C_1$.

[1] In well built commercial transformers, ω is considerably smaller, being for full load sometimes less than one degree, and angle $180° - \psi$ and angle $180° - \phi$ differ hardly perceptibly from 180°.

tion, and have the same direction only twice during each period, for angles between 90° and $90° + \varphi = 128.7°$; and 270° and $270° + \varphi = 308.7°$.

Impressed primary and secondary E. M. F. are of the same direction only twice per period for 10 degrees, for angles between 90° and $90° + \psi = 100°$; and 270° and $270° + \psi = 280°$.

Primary current and primary impressed E. M. F. have opposite directions, that is, the transformer sends back energy into the main-line, twice per period during 28.7°, for angles between:

$$90° + \psi = 100° \text{ and } 90° + \varphi = 128.7°; \text{ and } 270° + \psi = 280° \text{ and } 270° + \varphi = 308.7°.$$

In reality, in closed-circuit transformers φ and ψ are usually very much smaller than assumed here.

Thus all the phenomena met with in a transformer acted upon by sine-waves can be produced in the polar-diagram graphically by circles. Actual data of some commercial transformers will be given in a later chapter.

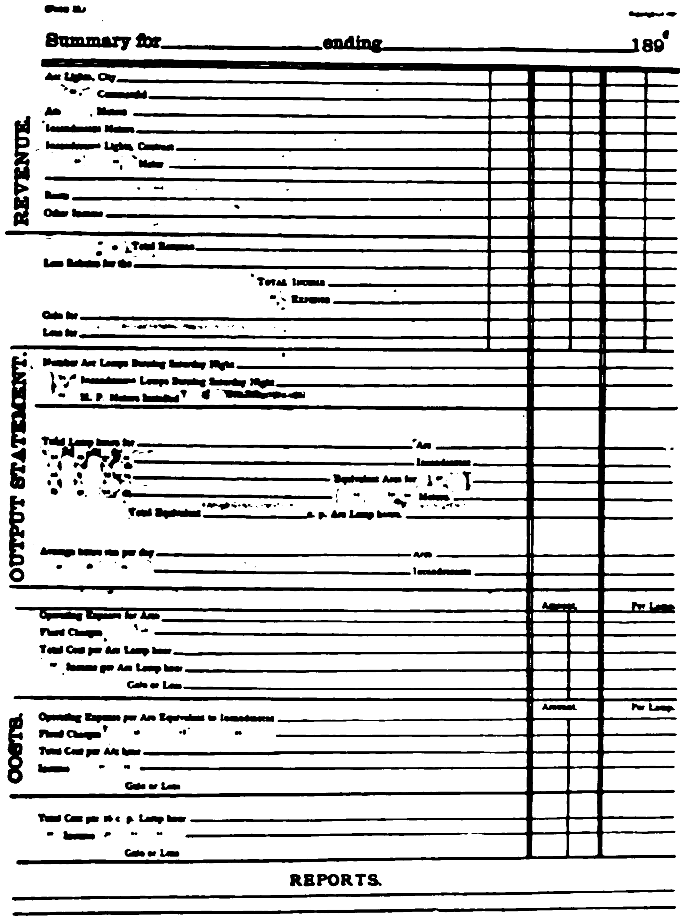
CENTRAL STATION MANAGEMENT AND FINANCE.—VII.

BY

Horatio A. Foster

Operating Expenses.

HAVING our reports of departments now in shape at the end of some stated period, say, a week or a month, a recapitulation of all the operating expenses should be made on blank No. 17.



Summary for ______ ending ______ 189

REVENUE.

Arc Lights, City
" " Commercial
Arc " Motors
Incandescent Motors
Incandescent Lights, Contract
" " Meter
Rents
Other Income
Total Revenue
Less Rebates for the
Total Income
" Expenses
Gain for
Loss for

OUTPUT STATEMENT.

Number Arc Lamps Burning Saturday Night
" Incandescent Lamps Burning Saturday Night
" H. P. Motors Installed
Total Lamp hours for ______ Arc
______ Incandescent
______ Equivalent Arc for
______ Motors
Total Equivalent ______ a. p. Arc Lamp hours
Average hours run per day ______ Arc
______ Incandescents

Amount | Per Lamp
Operating Expenses for Arc
Fixed Charges
Total Cost per Arc Lamp hour
" Income per Arc Lamp hour
Gain or Loss

COSTS.

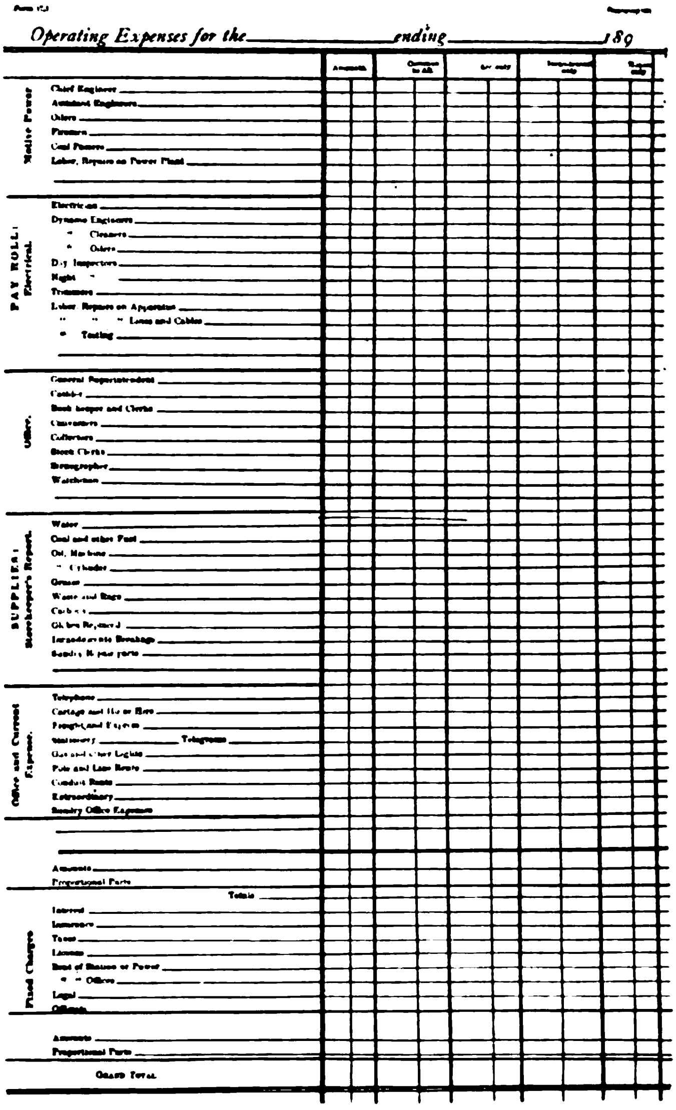
Amount | Per Lamp
Operating Expenses per Arc Equivalent to Incandescent
Fixed Charges " " "
Total Cost per Arc hour
Income " "
Gain or Loss
Total Cost per 16 c. p. Lamp hour
" Income " "
Gain or Loss

REPORTS.

BLANK No. 18.—SUMMARY OF INCOME ACCOUNT.

The first three divisions are taken directly from pay-rolls; the next is from the Storekeeper's Report, No. 13, of supplies issued for operating, and the last two divisions are filled in by the clerk from office data. The first column for figures is for the amount or value of the individual items, the second column for all those items which are common expense to all departments of out-put, such as coal, water, cylinder oil, superintendence, &c.

The third column is for such items as are used for arc expense only, including trimmers, carbons, globes, &c.; the fourth is for incandescent expense, like lamp breakage, inspector, &c., and the fifth column for motor expense only, including brushes and other supplies used expressly and exclusively for that purpose.



Operating Expenses for the ______ ending ______ 189

Amounts | Common to All | Arc only | Incandescent only | Motor only

PAY ROLL: Motive Power.
Chief Engineer
Assistant Engineers
Oilers
Firemen
Coal Passers
Labor, Repairs on Power Plant

PAY ROLL: Electrical.
Electrician
Dynamo Engineers
" Cleaners
" Oilers
Day Inspectors
Night "
Trimmers
Labor, Repairs on Apparatus
" " " Lines and Cables
" Testing

Office.
General Superintendent
Cashier
Book-keeper and Clerks
Canvassers
Collectors
Stock Clerks
Stenographer
Watchman

SUPPLIES: Storekeeper's Report.
Water
Coal and other Fuel
Oil, Machine
" Cylinder
Grease
Waste and Rags
Carbons
Globes Replaced
Incandescent Breakage
Sundry Repair parts

Office and Current Expense.
Telephone
Cartage and Horse Hire
Freight and Express
Stationery ______ Telegrams
Gas and other Lights
Pole and Line Rents
Conduit Rents
Extraordinary
Sundry Office Expenses

Amounts
Proportional Parts
Totals

Fixed Charges.
Interest
Insurance
Taxes
Licenses
Rent of Station or Power
" " Offices
Legal
Officers

Amounts
Proportional Parts
GRAND TOTAL

BLANK No. 17.—SUMMARY OF OPERATING EXPENSES.

The footing of the second column of "common to all" is divided among the columns three, four and five in proportion to the amount of the weekly or periodical out-put of each class, all, of course, being reduced to a common base unit, say, equivalent to full arc lamp hours. The total footing of these last three columns thus gives the total cost of producing the number of units of out-put of each class, and, by division, the cost per unit of the same.

In the average station, such as is considered throughout in these reports, it will be found most convenient to take the arc lamp of the class used therein for a base unit and reduce all other out-put to that unit by comparing the number of watts used by each. Motors are somewhat more difficult of calculation, but taking one h. p. of motor as equal to one full arc lamp will be found nearly correct, as the motors are seldom run regularly up to full power.

In calculating costs by the above method, it will be noticed that actual count is taken in all arc lamp work, whereas the ampere record is taken for out-put from the incandescent circuits. The two classes of service are so entirely different that it is quite difficult to bring them closely into line on any fair basis, and as the loss on arc wire service is comparatively small and constant, and as the same is varying constantly with the load on incandescent service, it is thought to be the best way to take the surest points of both. As a matter of fact, the calculation of costs must be made comparatively, and if cost is figured on out-put at the switch-board, and income is figured on the same basis, the comparison for profit is the same as if it be figured on, say, the total number of lamps wired. Again, in figuring for costs per incandescent lamp wired, and income for the same, it would hardly be fair to compare a station which kept current on only during a short period, with one running 24 hours a day.

To accompany the expense account Form 18 is made to show the income account for the same base units, and all data for unit costs is written in on this blank. The clerk can fill out this sheet mostly from office data, and can also do all the calculating.

THE PHONOGRAPH IN BUSINESS.

BY

F. R. Colvin

It is unfortunate that the phonograph is regarded by the public—particularly by the commercial part of it—as only a wonderful toy, furnishing an evening's entertainment under skillful manipulation, though lately having risen to the utility of a "nickel-in-the-slot" machine. With this opinion prevailing, it is difficult to make the average business man believe that with an hour's practice he can make the phonograph a simple, reliable and indispensable adjunct to his office equipment. It is interesting to note that when the nature of the phonograph was first known, prediction was at once made that stenography would succumb to the machine; on the contrary, the phonograph has come to be the stenographer's best friend. Returning from the court room or lecture at any hour of the day or night, he can easily dictate his notes into it at a speed of 250 words per minute, and have a dozen typewriters, if necessary, simultaneously transcribing them the next morning before he has made his appearance at his office, or while working on another case.

My purpose is, however, to indicate the true function of the phonograph in daily business use as impressed upon me by my acquaintance with this acquisition in the office of The Electrical Engineer. We do not use it in lieu of, but in connection with, the stenographer. During the last hour of each day, our phonograph receives dictation for transcription early the following morning. The cylinders accumulating from this dictation are transcribed while the mail is being opened and distributed, and before it is time for the regular dictation of the day's mail to begin. The distinctive advantage in the use of the phonograph in letter dictation is that the simultaneous presence and work of two persons are not necessary. One wishes to rush off certain matter and leave the office for an hour—no stenographer is immediately available; Miss A. may be receiving dictation; Miss B. may be preparing something for the editorial department that must be ready by a given time; Miss C. may be out at lunch. The phonograph, however, is always ready—a cylinder is quickly adjusted and the matter dictated, a note being left in the office to the effect that cylinders Nos. 1, 2, 3, 4 and 5 are to be transcribed and the letters must be ready by 5 p. m. On returning to the office the letters are ready, awaiting signature. It frequently happens that manuscript must be copied at once and sent away; it sometimes occurs that important work has to be suspended to admit of such copying. A man brings something into our office of which we wish a copy and says, "You could have a copy only I haven't time to wait—I must take it with me." We ask him if he can wait while we read it. "Yes," he says. "All right, we will read it aloud into the phonograph." This being done, our friend may leave with his precious paper at pleasure, and the matter may be copied off from the machine the next day or the next week—whenever most convenient. How often it happens that a manager thinks of a letter which should be written at once, but which waits over until the next day or perhaps is never written, simply because no stenographer is conveniently available at the time; he may make a note to write the letter and lose the note or tear it up upon second thought. It is unnecessary to point out the value of the phonograph in this connection in petrifying and preserving impulse. It is, perhaps, true that phonographs have been placed on trial in some business offices and returned to the company with the verdict of "failure." The verdict was, no doubt, a just one; but it was not "failure" of the machine, it was "failure" of the man. Speech will not come out of a phonograph more clearly than it goes in. One should spell out queer proper names and unusual words just as he would to his stenographer in ordinary dictation. He should speak moderately loud and remember that he is talking to a machine that is a merciless critic and a truthful one whose motives cannot be impugned.

Simple routine letters, such as those of acknowledgment and the great mass of short letters we all handle from day to day, can be rattled off into the phonograph with short practice; but there are few people living who can compose a smooth letter of considerable length and dictate it continuously into the machine without hesitation. A feeling of solitary stage fright comes over one at first which takes time to dispel; in the presence of this eternal echo one hears his imperfect self, recognizes his shortcomings of diction and ought to be frightened. It is well, then, to make a skeleton, either on paper or in the mind, of longer letters and then read them into the phonograph as rapidly as is desired.

The phonograph is, therefore, a great doctor for the hesitating dictator who has not digested what he intends to say. This dyspepsia of dictation however readily yields to the pepsin of practice and the pancreatin of persistence. The phonograph also makes itself felt in our office on the occasion of the impending absence from the city of the manager. A larger number of cylinders is "loaded up" on such an occasion than usual, to be written out at leisure during the next day or two. This particular use of the machine might be availed of in the case of The Electrical Engineer to a greater extent, were it not for the simultaneous use made of the long distance telephone, which keeps the phonograph busy even in the absence of the writer. Whether I am in Philadelphia, Washington or Baltimore, in Erie or Buffalo, in Rochester or Boston, the morning mail is read to me over the long distance telephone from New York by one of our stenographers, and the answers taken down in short hand at the New York end of the wire. Ten minutes after I hang up the telephone in Buffalo or Washington, the stenographer is reading his "overflow" notes into the phonograph for distribution, and the mail dictated over a wire from two to five hundred miles long in the morning, goes out of our office in the evening just as though I had been there all day. This is not a dream or a future possibility; it is what is done in this office as frequently as absence makes it necessary, and what many more houses are doing from day to day as the advantages of modern electrical facilities are more appreciated and understood.

For the benefit of those more or less unfamiliar with the phonograph, I would say that there are three sources of power in use, any one of which is suitable for the propulsion of the phonograph motor. First, electric light mains ; second, storage batteries ; third, primary batteries of great length of life and absolute constancy. Where power is derived from the electric light mains, a specially wound motor is furnished. The use of the phonograph on a large scale probably most nearly approaches perfection in one of the large electrical offices where no fewer than 30 of these instruments are inconstant daily operation. Here heads of different departments and their assistants dictate all their mail into phonographs alongside their desks and send the loaded cylinders to the phonograph room of their department to be transcribed by one of half a dozen or more typewriters, who also are provided with phonographs on which cylinders are placed and worked off as soon as received. The cylinders are then sent to another phonograph, which is kept busy all day shaving them, after which they are returned for use again. The question is always asked: "How much do these cylinders cost, how many letters will they take apiece, and what do you do with them after using?" They cost 20 cents apiece, will receive easily from six to ten letters of less than a page length, are furnished promptly by the phonograph company either on written or telephonic order. They are shaved by simply setting a little knife or plane and turning on the current. In my office the tonsorial part is satisfactorily presided over by an office boy, so it will be seen the process does not involve the intricate. A dozen cylinders shaved once a day will take care of a good sized correspondence of from fifty to one hundred letters per day, according to their length and the practice of the operator. The yearly rental of the phonograph alone is $40. Where a primary battery is provided and kept charged by the company, the rental is $55. Where current from the mains is used, one pays $40 per year for the machine and settles with the electric light company for the current used as per meter. This is the best and cheapest way.

The day is, I believe, coming, when fifty out of one hundred offices having typewriting machines will use this instrument, and when the veil of mystery will no longer conceal in its voluminous folds the true uses and possibilities of the Edison Phonograph.

THE THOMSON RECORDING WATTMETER.

THE announcement made in our columns last week that Prof. Elihu Thomson had been awarded the first prize,[1] for his recording wattmeter in the Paris Meter Competition, has, it seems, created widespread interest and satisfaction in electrical circles, and we have received numerous communications requesting further information regarding the construction and operation of the instrument tested at Paris. The meter in question was described in our issue of November 5, 1890, but it may not be amiss to recall briefly its salient features, and to add some further information regarding its use in practice.

The conditions which Prof. Thomson set out to fulfill in his meter were as follows : 1. It should register the watt-hours ; that is, the summation of *energy*, and not of current, delivered to any circuit. 2. It should be adaptable for either continuous or alternating circuits. 3. There should be accuracy throughout the entire range of the instrument. 4. The instrument, so far as possible, should give direct readings, and all constants for sake of simplicity avoided. 5. The instrument should combine simplicity of design and parts with noiselessness and durability.

All these conditions have been met in the meter which is illustated in the accompanying engraving, Fig. 1. As will be seen, it consists of a vertical shaft resting in a jewelled bearing below, and, guided by an upper bearing, carries on its upper part a hollow frame wound with a set of coils, forming a sort of Siemens armature of polygonal outline without any iron core. The coils of the armature are attached to a commutator carried on the shaft near its upper bearing, the commutator being made of a little larger diameter than the shaft on which it is placed, and is of special construction both as to material and mounting of its parts. Two light springs bear upon the commutator and constitute the commutator brushes. The armature coils are wound with fine wire and in circuit with the armature is placed a non-inductive resistance, carried in the frame at the back of the meter.

The armature coils have placed adjacent to, and surrounding them, a set of fixed coils, generally made without iron, through which coils the main current to be measured passes. They furnish an air field of greater or less strength according to the current flowing in the coils. An endless screw on the shaft engages with a wheel in the registry train whereby the rotations of the armature are recorded.

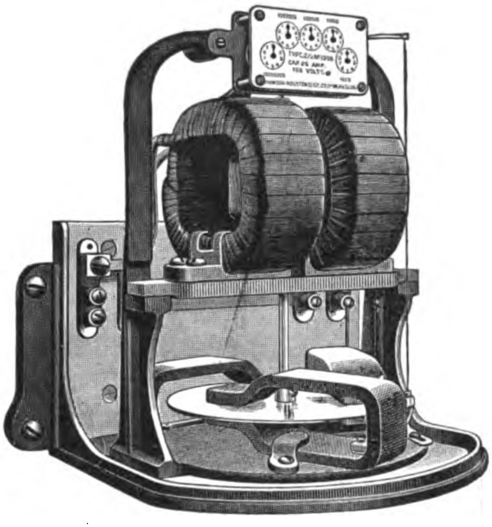


FIG. 1.—THE THOMSON RECORDING WATTMETER.

On the lower part of the shaft which bears the armature is mounted a copper disc the plane of which is at right angles to the length of the shaft, and which rotates with the shaft. This copper disc moves between the poles of a number of permanent magnets which are placed so as to embrace it.

The principle of action is quite simple. The amount of load or retardation obtained by the copper disc moving in the magnetic field is directly dependent on the speed, and the retarding effect may be said to vanish when the motor stops, and to increase regularly as the speed increases. In like manner the torque or turning force exerted by the armature may be said to vanish when the field current becomes nil, or when there is no load, and to increase regularly under constant potential between the mains as the load of lamps, or other working devices, is increased, that is, as the current passing through the stationary field coils increases. The result of this is that the speed of the meter shaft increases in strict proportion to the load so that the registry is uniform throughout the range, except with the very smallest loads.

The meter which is applicable to both direct and alternating current circuits registers the energy in watt hours, which can be read directly off the dials.

It has been found from tables that have been carefully calculated, that an incandescent lamp consuming 1,000 watt-hours of electrical energy will give about one-tenth of the illumination given by 1,000 feet of gas under ordinary circumstances ; consequently, in order that the customer may pay for electric light at the same proportionate rate for the same illumination that he has been paying for gas, the price per thousand watt-hours of electricity can be placed at one-tenth of the price per thousand feet of gas. This permits of a ready method of calculating the charges from the meter readings, and this computation is done practically automatically by the use of the chart illustrated in Fig. 2. In this chart, dollars and cents are read off on the vertical line on the left, while the horizontal line at the bottom indicates thousands of watt-hours. The diagonals indicate the lines to be taken as reference, depending upon the price charged per 1,000 watts, which, of course, varies in different localities.

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[1] The first prize was awarded jointly to Prof. Thomson and Prof. Aron, for their respective meters.

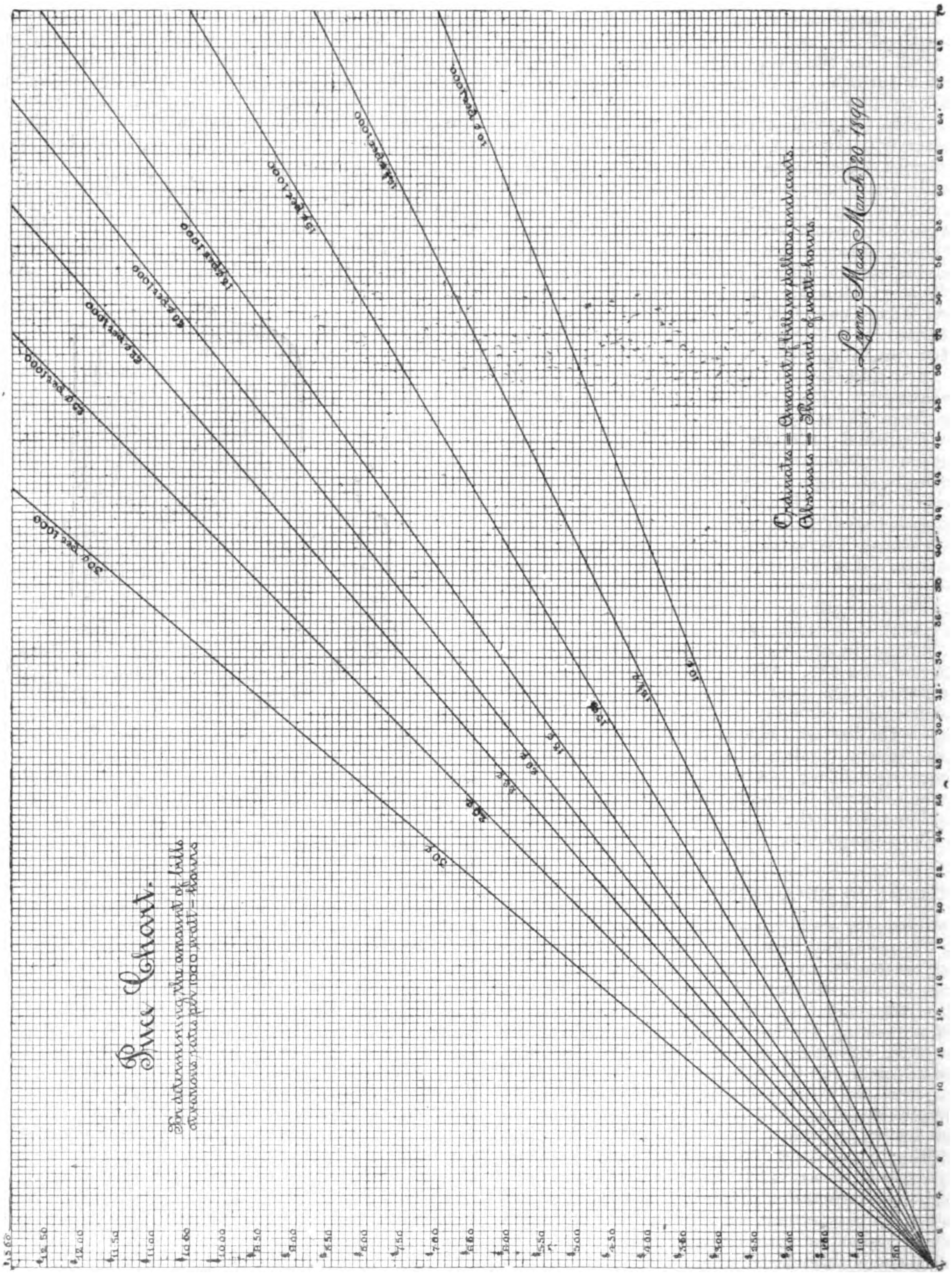

Fig. 2.—Chart For Computing Thomson Meter Charges.

We may add that though but a few months have elapsed since Prof. Thomson submitted his successful meter to the Paris Testing Committee, a number of improvements have been introduced which add still more to its value.

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

BY

C. J. Hubbell

I NOTICE, among the Transactions of the American Institute of Electrical Engineers at a special meeting held April 21, 1891, a paper was read by Mr. N. D. C. Hodges, "On Possible Modifications in the Methods of Protecting Buildings from Lightning," which provoked considerable discussion among the members present, and during which my name, as "a well-known lightning rod manufacturer," was mentioned by Mr. Edward P. Thompson in connection with a series of experiments.

I would like to say a few words in answer to Mr. Hodges' theory, that a dissipated conductor protects. He asserts, moreover, that there is no instance on record where a dissipated conductor has failed to protect. It is a well-known physical law, that can be readily proved to the satisfaction of any intelligent person, that the earth is a permanent magnet, and the rendezvous of all thunder storms. When a cloud, charged with a given kind of electricity, approaches the earth, the latter, that is the subterranean sheet, or permanent moisture belt, becomes charged with an electricity of an opposite polarity. The two electricities attract each other; the electricity of the earth precipitates itself upon the lines of least resistance, gathering up in increasing intensity to the higher points under the attraction of the storm cloud, until sufficient potential has accumulated to overcome the resistance of the dielectric, when a discharge takes place and the equilibrium is restored.

There are more, what is commonly called, "upward strokes" than "downward" ones, and more disasters have occurred from the former than from the latter. Yet Mr. Hodges ignores the earth connection entirely, without even resorting to the method of Clerk Maxwell by insulating the building from the earth. I might say to Mr. Hodges, with more truth than is contained in his assertion, namely, "that there is no instance where a dissipated conductor failed to protect," that there is no instance on record where a well ordered and properly constructed lightning conductor of sufficient capacity and good and intimate connection with the subterranean water bed or permanent moisture belt, failed to protect.

I herewith submit a few well authenticated instances where a dissipated conductor failed to protect. Anderson, in his well-known and standard work on "Lightning Conductors," contains the following passages bearing directly on this subject:

Page 315. Date, July 21, 1745. Tower of Monastery of Bologna. Result: Shattered. Lightning followed conductor and *melted it.*[1] Authority, Reivnarus Bl. 93.

Page 315. May 31, 1748. Top of a church tower, Witzendorf, shattered and tore off the roof. *Melted the conductor.* Authority, *Hamburg Magazine*, IX., 301.

June 16, 1754. Belfry of Newbury Church damaged, point of spire shattered and other damage. *Conductor melted.*

Page 186. Prof. Landriani, of Milan, draws attention to the paramount importance of a perfect earth connection.

Page 312, same authority. On Trinity Sunday, June 8, 1879, a violent thunderstorm broke over the town of Arxham about half-past three in the afternoon, and the spire of St. Mark's Church was struck by lightning. A Sunday-school class was being held in the room at the base of the spire and the teacher and five of the scholars were burnt. Some of the stone work of the spire was also displaced and thrown down. Cause: A copper conductor of too small capacity and the earth connection not adequate.

Many more instances could be given in addition to the above.

Referring to the article in the London *Electrical Review*, quoted by Mr. Hodges, in which it is said that lightning does not play as destructive a part as it did forty or fifty years ago, and that even those ships unprovided with conductors had suffered less damage than a smaller number of ships experienced formerly, etc., I reply, that the reason that modern vessels are less frequently injured by lightning than formerly, is because of the fact that more vessels are now built of iron, and the still more important reason that wire rigging instead of rope, as formerly, is almost universally used, while, in addition, the masts of many vessels are of iron and hollow. I could cover many pages with what should be accepted as strong evidence for the necessity of a good earth connection and a refutation of what I cannot but regard as a very unscientific statement based upon no valid reasoning, that a dissipated conductor protects. Certainly Mr. Hodges, with his strip of copper 75 feet to the pound, placed as an offering to the insatiate monster in order to protect the structure, magazine, etc., it is tacked on to, has but a very small conception of the potentiality of a discharge of lightning whose disruptive powers are such as to hurl tons of granite from their foundation as if they were but feathers, so that it may take the path of least resistance, to the water which it was seeking in order to be *dissipated* by being neutralized.

In conclusion, I desire to correct a statement about myself made by Mr. Thompson. It was five years ago, not three, that Mr. Thompson, upon my invitation came to a room in the Standard Oil Co.'s new building to witness my experiments with a six plate electrical machine using a spheroid as a cloud. The gas from the gas pipe in the room was used to charge the model oil tank used in the experiments. Profs. Morton, Plympton, and Nason, of Troy, were also present, and the experiments were absolutely successful; but because I refused to dispose of my invention for a trifle, the company refused to adopt it.

I applied the same principle to the U. S. Government magazine, at Dover, N. J.; also to the Wellesly College building at Wellesly, Mass., where 9 conductors, all of which were tested by Prof. Holman, of the Mass. Inst., of Technology, Boston, showed the highest resistance of ground or conductor to be .3 of an ohm. I also predicted the striking of the Washington Monument, giving my reasons for the same, and my prediction was fulfilled when, three weeks later, the capstone was shattered. I was called upon to advise a method of protection, and in response to suggestions, the connection of all masses of metals about the plinth was carried out and a crown with many points substituted for the single aluminum point; since then no further disturbance has occurred.

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[1] These and the subsequent italics are mine.

ELECTROLYTIC PRODUCTION OF CHLORATE OF POTASH.

THE works at Vallorbes are now producing, the *Bulletin International* says, one ton a day of chlorate of potash by the electrolytic process of Gall-de-Montlaur. The output is one kilogramme (2.2lb.) per horse-power every day of 24 hours. The process consists in electrolysing a solution of 25 per cent. of chloride of potassium at the temperature of 45 deg. to 55 deg. C. Chlorine and potassium are set free, which again react upon the chloride not decomposed, and transform it into chlorate of potash. When the electrolysis is complete, the chlorate is precipitated by successive crystallisations. The manufacture presents several practical difficulties; it is indispensable, among other things, that no metallic particle whatever should come into contact with the baths, on account of the formation of chlorides and oxides, whose presence render the purification difficult, if not impossible. The present works comprise 270 vats, of which half are in actual use. This corresponds to an output of 50,000 litres of solution a day. The anodes are of iron, separated from cathodes of platinum by a porous diaphragm. The temperature of the bath is maintained constant by the passage of the current.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

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VOL. XI. NEW YORK, JUNE 17, 1891. No. 163.

Every ultimate fact is only the first of a new series. Every general law is only a particular fact of some more general law presently to disclose itself. There is no outside, no enclosing wall, no circumference to us.—Emerson.

SUB-CELLAR ELECTRIC RAPID TRANSIT.

THERE has been remarkably little show of opposition to the plan of underground electric rapid transit as proposed by the Rapid Transit Commission for New York City. Not only has there been a general approval of the plan in New York, but outside, where people are in a position to judge freely and impartially, the commendation has been very hearty. Visitors to New York are more impressed with its lack of travel facilities than are the inhabitants, who long since came to the conclusion that they must necessarily be crowded while in the cars and deafened or becindered when walking near them.

The main criticism or opposition has come from two papers, the *Morning Journal* and the *Sun.* The chief objection of the former seems to lie against the tunnel as a tunnel, and not against electricity as a motive power. And yet there is no evidence to prove that the tunnel now being operated in this way in London is in the slightest degree offensive to health or to any of the senses. The London correspondent of the *New York Times* testifies to the direct contrary. So does the London correspondent of the *Boston Herald,* who says: "What impresses you with decided favor is the *brightness* and *lightness* and *cleanliness* of the whole thing. The electric current gives light as well as motion, *the air is fresh,* the coaches are comfortable and the speed delightful." And such is the testimony of every person we have seen who has taken a ride over the road.

But the *New York Sun,* which in a ponderously humorous way has been trying to make fun of what it calls "sub-cellar rapid transit," wants to know, you know, whether people prefer to travel in the air and sunshine or in a clammy, unwholesome, stuffy atmosphere, with poor lights and every possible discomfort. Well, it happens that it is quite the other way, you know, for if ever people traveled in a clammy, unwholesome, stuffy atmosphere, with poor lights and every possible discomfort, they do it now pretty well every day of their lives on the Elevated Railroads of New York.

But the *Sun* is not satisfied with its false parallel. It goes on as follows at another time, in comment upon some excellent remarks made by the *Philadelphia Press:*

> The Rapid Transit Commission report provides that the motive power of the proposed underground railway "shall be electricity or some other power not requiring combustion within the tunnel." The length of the road is to be twenty miles. No system which will not enable trains of four or five cars to pass over this distance in three quarters of an hour, at the slowest estimation, deserves the name of rapid transit. Longer trains will in all probability be necessary. A speed of at least thirty miles an hour will be indispensable. The accomplished engineers of the Commission may be able to report to it that they have found a motive power equal to the task, but if they have, the discovery will be a surprise to the world. The cable system is out of the question. It is unequal to providing within ten miles an hour of the requisite speed, and, besides, the cables are always breaking. Does the *Philadelphia Press,* or anybody else, know of an electric motor which can draw even one loaded passenger car at the rate of thirty miles an hour, or even of twenty miles an hour? Until such an electric motor or some other motor not dependent upon combustion can be constructed there can be no underground rapid transit answering the conditions prescribed by the Rapid Transit Commission.

All we have to say is that electric motors to-day, all over this country, are doing just such work, and that in the service between St. Paul and Minneapolis they have been so successful that they have already supplanted the old steam service. More than five years ago we had the pleasure ourselves of riding behind electric motors under just such conditions and have done it many a time since. There is nothing at all wonderful or extraordinary about it. The amazing thing is that the *Sun* should allow itself to remain in such utter ignorance of what electricity is doing in the field of locomotion. It is a paper from which one expects, and generally gets, much better things.

Still we are not seeking the unsatisfactory resource of mere rhetorical controversy, nor do we care to ply our readers with facts that they long since became familiar with. We are relieved of the necessity, if it exist, of pushing the matter, by the flat-footed challenge to the *Sun* from Mr. Frank J. Sprague, published in the Saturday *Evening Post.* Mr. Sprague there puts himself under a fine of $50,000 to meet just exactly the conditions that the *Sun* intimates cannot be met, and adds other conditions to make the task as onerous as any that could occur with the proposed underground electric rapid transit system. The opponents of the plan on the ground of its electrical impracticability can either take up the challange or, to put it plainly, "shut up."

REFORM IN TAXATION.

ONE by one "Campaigns of Education" on public questions are undertaken by public-spirited citizens who have the will and courage to put their convictions into expressions and actions. The movement for civil service reform, both

National and State, has gone far and accomplished much; the agitation of the past few years for tariff reform has awakened or created a wide-spead belief that the existing economic system is neither just nor wise. It is further encouraging to note the formation of the New York State Tax Reform Association. Its aims and objects are set forth in a circular as follows:

1. The most direct taxation is theoretically the best, because it gives to the real payers of taxes a conscious and direct pecuniary interest in honest and economical government.
2. Mortgages and capital engaged in production of trade should be exempt from taxation, because taxes on such capital tend to drive it away, to put a premium on dishonesty and to discourage industry.
3. Real estate should bear the main burden of taxation, because such taxes can be most easily, cheaply and certainly collected.
4. Our present system of levying and collecting State and municipal taxes is extremely bad; spasmodic and unreflecting tinkering with it is unlikely to result in substantial improvements.
5. No legislature will venture to enact a good system of local taxation until the people, especially the farmers, perceive the correct principles of taxation and see the folly of taxing personal property.

The principles thus set forth will doubtless secure the assent of many citizens who have given some serious thought to the subject of taxation. Their advocacy and public discussion may fairly be expected to bring about a more adequate comprehension of the general subject on the part of voters, and a more enlightened sense of their true interests as tax-payers. Directness of taxation and certainty in assessment—which latter desideratum can never be achieved as to personal property without an inquisitorial process wholly intolerable to self-respecting citizens—are principles well established in the minds of students and investigators, but they have not yet secured acceptance by the general public, and particularly have not attained the assent of the farmers. If the Tax Reform Association succeed in convincing the holders of farm property that it will be money in their pockets to release mortagages and other personal property from tax, the battle for tax reform will have been won. There are abundant indications that the rural voters throughout the country are keenly aware that much is amiss in National and State taxation. The inauguration of the New York Tax Reform Association is timely and promising. It is gratifying to observe the name of so distinguished an authority and expert in economics as Hon. David A. Wells heading the list of signatures to the preliminary circular of the Association.

The secretary of the Association is Mr. Bolton Hall, and its address is Room 99, 111 Broadway, New York. Mr. Hall invites correspondence and co-operation from all who appreciate the need of more systematic and enlightened methods of raising the revenue of the state.

LIGHTNING CONDUCTORS.

The controversy which was carried some time ago in England between Dr. Lodge on one side and Mr. Preece on the other has done probably more than anything within recent years to call attention to the diversity of opinion which still exists on the subject of the proper protection of buildings from lightning. The theories advanced by Dr. Lodge were in consonance with the results of his experiments on the alternative path, and the side flash of neighboring conductors was also introduced as a prominent factor. Mr. Preece, on the other hand, contended that, without seeking new theories, the results of the best past practice were a sufficient guide for our future course in the protection of buildings and apparatus from lightning. This controversy has hardly died away before we are confronted with a new theory involving a radical change in the construction of lightning conductors, due to Mr. N. D. C. Hodges, who contends that by employing a dissipatible conductor the potential of the lightning discharge can be lowered sufficiently to deprive it of its destructive qualities. We believe that Mr. Hodges has not yet had occasion to demonstrate the correctness of his theory by the erection of a lightning conductor constructed on this plan, and hence the subject is still open for discussion. It is for this reason that we give space this week to a few remarks from Capt. C. J. Hubbell, in which he cites experience in support of his arguments, controverting the theory of Mr. Hodges. It seems indeed strange that the earliest practical application of electrical science, the lightning conductor, should still be a debatable subject; and stranger still that, following the discussion of the relative merits of the rod or the tape form, which began with Faraday and Harris, we should now be discussing solid or dissipatible conductors.

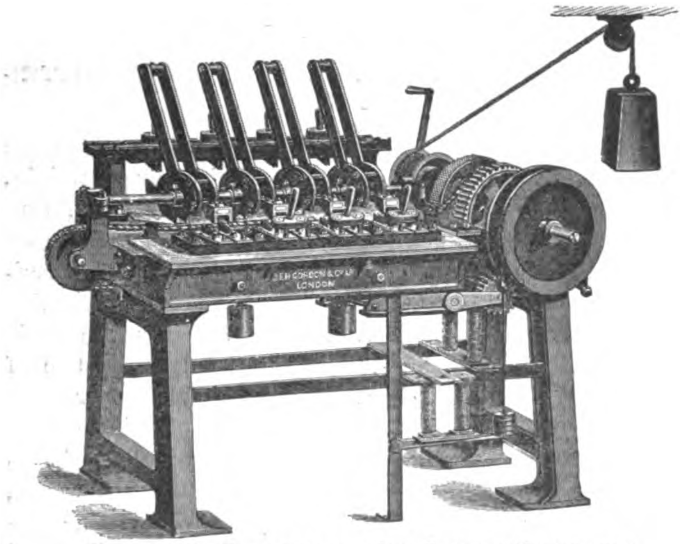
SIR WILLIAM THOMSON ON METHODS OF DISTRIBUTION.

The eminent position occupied by Sir William Thomson gives his utterance on any electrical subject great weight, and, as such, a recent report of his on the electric lighting of Glasgow, together with some comments on analogous subjects, before the London Institution of Electrical Engineers, has, it seems, attracted considerable attention abroad. In the report referred to, Sir William recommends the city to adopt the low-tension direct current system of distribution, which he characterizes to be for many reasons decidedly preferable to the high-tension alternating current with transformers, adding that the supply ought to be as near as may be to the district to be lighted, and the nearer, the better for economy. He also advocated the same system, as above stated, before the Institution of Electrical Engineers on account of the great simplicity which this method possesses. We believe that no one will find fault with Sir William's suggestions if properly analyzed. As he says, the great simplicity of the direct system makes it the one to be employed of all others, where the conditions allow of its use, and such evidently appear to be those obtaining at Glasgow. But we do not think that Sir William intended to convey the impression that the low-tension direct system was the one best adapted to all conditions of supply. It is true that electricians, especially in England, are inclining more and more to house distribution at low pressure from sub-stations, and with good reason; but this is independent of the kind of current employed, and can be said with equal truth of both the direct and the alternating system. No one will deny, probably, that the direct system of supply is simpler in some respects than that of the indirect method with converters, but the great advantages of the latter, where the conditions call for its employment, far outweigh this objection. The alternating current system of distribution needs no defence at our hands, and it is safe to say that the remarkable progress in electric lighting is largely due to this system, with its capacity for economically covering wide areas of distribution from a single point.

THE TOMLINSON SUB-STATION REGULATOR.

As electrical engineers become more fully alive to the waste of power in transformers kept in circuit all day at light loads, the sub-station method of distributing alternating currents is coming to the front more and more. Mr. J. E. H. Gordon, of London, has recently exhibited a most ingenious sub-station regulator, the invention of Mr. Thomas Tomlinson, and designed for cases where there are a number of transformers at each sub-station.

The Tomlinson apparatus, shown in the accompanying illustration, is provided with four sets of switches, and the transformers are arranged in five groups. One group is permanently connected to the mains, and one more is connected through each set of switches respectively. Suppose that one transformer is permanently connected to the mains; then one would be connected to the first switch, two to the second, four to the third, and eight to the fourth, so that the putting in of each switch doubles the number of transformers in circuit. With a current of 1,500 lamps on a single switch no spark whatever is visible. The switches are thrown over by a sliding carriage in the form of a double wedge, which runs backwards and forwards along the bed-plate of the machine, and, as it passes each switch, throws over a tumbling lever, which strikes the switch suddenly in or out of contact.



Tomlinson's Transformer Sub-Station Regulator.

This carriage is moved by an endless chain actuated by two weights, which are released respectively by two electromagnets. The large weight which takes the transformers out of circuit has to be wound up once a week, and, as it takes out the transformers, it at the same time winds up a smaller weight ready to put them in again. If any failure whatever of the large driving weight occurs, or if the attendant forgets to wind it up, the small weight is always ready to put the whole of the transformers into circuit, and must do this before the apparatus becomes inoperative.

The apparatus has been tried practically through the courtesy of the Brush Company, the Electric Construction Company having also lent transformers for the experiment. The plant was first run for twenty-four hours with the transformers connected in the ordinary manner, and then for twenty-four hours connected through the Tomlinson regulator, and coal and water were measured throughout the experiments. The actual saving in coal was carefully determined, and the use of the regulator showed a saving amounting to an extra dividend of nearly two per cent.

Mr. L. W. Dillon, of the Attleboro, Mass., Electric Light Co. has, under the new organization been appointed superintendent of the electric company and the street railway company.

ELECTRIC FORGING.

BY

Otis K. Stuart.

The most valuable feature of electric forging is, perhaps, the power it gives us of *localizing* heat in a mass of metal. The only portion of a metal rod heated in an electric forger is the length between the two clamps, and obviously this may be made longer or shorter at will, it being necessary merely to increase or decrease the electromotive force of the secondary current accordingly. And this is obviously true of all metals, whether of high or low electrical resistance, whether of high or low melting temperature, whether the pieces be of large or small sectional area. It is thus possible to generate the heat just where it is desired to perform the forging operations, and the original shape of other portions is thereby retained—a difficult feat to accomplish oftentimes by the ordinary methods.

The chief reason, perhaps, why electric forging has not been introduced into the metal working industries as yet, is that it is too *expensive*. Electric welding is economical as compared with ordinary forge and hammer welding, because the operations can be performed with greater rapidity and the heat can be confined to the *ends* of the pieces to be joined. The smallest amount of time and a minimum amount of heat are required. But in forging operations large masses must generally be heated, and it is well-known that the production of heat by electricity is an exceedingly expensive process. Besides, the vast mass of forging which is done in the shops of this country is on pieces of metal which vary infinitely in shape and size, and thus clamping would be difficult, as good contact must be secured between the clamps and the pieces to be forged, and it would be impossible to build apparatus which could perform such a great variety of motions as would be necessary to give a variety of shapes to the metal. It has been found impossible to make a universal welding machine, but it would be far more difficult to make a universal electric forging machine, because the latter, from the very necessities of the case, would be a much more complex apparatus.

Still, as we stated above, the great objection to the electric process of forging is the expense of generating the heat. Even if pieces of iron no larger than 2″ diameter and 6″ length are to be heated to a temperature high enough for easy forging, about 75 horse-power would be required for several minutes. If copper is to be worked, still more power would be necessary. Smaller sections require proportionally less power, as the power necessary to heat metal varies, if radiation be left out of the estimation, directly as the masses of the pieces. It is clear that for use in large work, thousands of horsepower would be required, which would necessitate enormous engines or equally gigantic water powers. If the latter can be found and utilized, there would seem to be no reason why we should not then have immense forge shops in which not an ounce of coal would be burned, but all the heat for forging purposes would be generated from the energy of a waterfall through the medium of electricity. And until then, I do not look for any very considerable expansion of the electric forging industry.

FRANKFORT EXHIBITION.

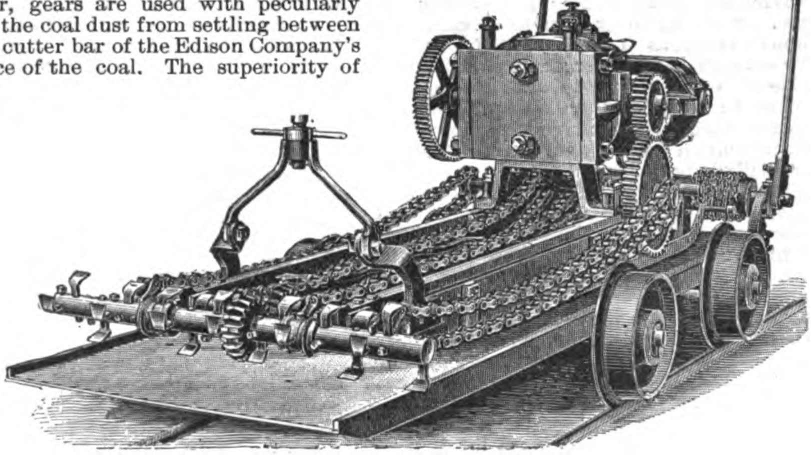
The work for the installation of the 300 h. p. transmission from Lauffen to the exhibition is being rapidly pushed forward. The 10,000 oil insulators required are already supplied, and the turbine at Lauffen is being erected. The work of manufacture of the electrical apparatus by the Allgemeine Company is being pressed forward, and it is expected that the whole will be ready well within the time stipulated.

THE EDISON GENERAL ELECTRIC CO.'S COAL CUTTER.

Of the many different coal cutters in use at present, those that have so far met with the best success are undoubtedly those using the cutter bar, that is, a shaft revolving parallel with the coal in a horizontal plane, and having knives distributed all around the surface, so as to cut a groove in the coal the entire length of the bar. The type of coal cutter adopted by the Edison General Electric Company, and shown in the accompanying illustration, has been in use for years, and has been thoroughly tested. This machine has the advantage of great strength, and is especially excellent as regards the design and the distribution of the material to give the necessary strength and rigidity. A special feature is that the cutter bar revolves in such a direction that the coal is cut upward. This method greatly assists gravity in holding the machine down to the ground, and to a great extent avoids the necessity of carefully fastening it by means of braces or jacks.

With machines using the cutter bar, the bearings holding this bar have necessarily to be very short, for otherwise the ridge of coal left standing in front of them, which cannot be reached by the cutters, would be too wide and strong to be readily broken away by the wedge-shaped front of the bearing. It has been customary to make these bearings 1¼ inches wide, and to transmit the power to the cutter bar direct by means of a chain. In this manner the cutter bar has not only to withstand the strain due to the resistance of the coal being cut, but also that of the chain itself, which, when 15 horse-power is transmitted to the cutter bar, amounts to 3,600 pounds.

The Edison Company has adopted a countershaft behind the cutter bar, to which the power is transmitted direct from the motor by means of four chains. This countershaft has bearings 6 inches long, and strong enough to withstand any strain the chains may exert on them. To transmit the power from the countershaft to the cutter bar, gears are used with peculiarly shaped teeth, which prevent the coal dust from settling between them. The only strain on the cutter bar of the Edison Company's machine is due to the resistance of the coal. The superiority of this construction is evident, when it is considered that the bar is very much weakened by the number of holes drilled in it to receive the cutting tools and the set screws required to hold them. The cutter bar is now about as strong as it can well be made. Any increase in diameter would also increase the height of the cut, which already is 4½ to 5 inches high.



Edison Electric Coal Digger.

There are other advantages in the design of the machine used by the Edison Company which make it adapted to withstand the rough usage to which it is subjected in mines. Among them can be named simplicity in design of the feeding devices, and the use of rollers for the sliding frame, which reduce to a minimum the friction between it and the stationary bed, and decrease the danger of binding between the two.

To determine the amount of power required for coal cutters, a number of tests were recently made with machines at work in coal of varying degrees of hardness. These tests have shown that a 15 horse-power motor is sufficient for the purpose. In some places the power required exceeded this amount, but as the machines only ran off and on, having their full load on for about four minutes at a time, a motor having the capacity mentioned was found to be sufficient; and a careful examination of the condition of the armature and magnet of the machine showed them to be perfectly cool.

The motor used for the Edison General Electric Co.'s coal cutter is capable of giving 15 horse-power when doing steady work. When running off and on only, as would be the case when used with coal cutters, it is capable of giving far greater power. This motor is especially well adapted to the work it has to perform; it runs entirely without sparking, and has all its vital parts well protected.

The Edison Company builds coal cutters capable of making a cut 4 feet, 5 feet, and 6 feet deep, by 3½ feet wide. They are all provided with trucks, by means of which they can readily be moved from place to place. The devices on the truck to load and unload the machines are very simple and efficient, and each machine is supplied with a cable 150 feet in length, and provided with devices to enable it to be readily attached to the main wires.

The average cost of equipping a mine with the electric plant necessary for mining 400 tons per day in a 5-foot vein of soft coal (the plant being operated 20 hours per day), is estimated at $9,500 exclusive of steam engine, boilers, and building.

THE DETROIT ELECTRICAL WORKS.

There is nothing small about the way in which the Detroit Electrical works is organizing its business and shops, with the determination of becoming one of the most prominent factors in the electric railway and motor field. It has just closed a real estate deal which gives it a block of 16 acres in Detroit, between Twelfth street and Wabash avenue, with a frontage of 453 feet on the Grand Trunk railroad. The Detroit Electrical Works contemplate putting up there one of the most extensive electrical manufacturing establishments in the country. The new works will include a machine shop, foundries, pattern shops, finishing shops, steam forges, erecting shops, carpenter shops and laboratories, and possibly a large power plant capable of furnishing electric current for the motors of the whole manufacturing establishment. The present works will be continued in operation for the manufacture of various kinds of electrical supplies and machinery.

The mechanical shop of the new works will be a large structure and each department of the work will be entirely separated from the others. All of the shops will be fitted up with overhead electrical traveling cranes, and they will be used for the manufacture of electrical machinery in its various forms, as may be developed from time to time. The intention for the next year's work is to turn out at least five complete steel car electrical equipments per day and one complete generator of a capacity of not less than 100 h. p.

The cost of the buildings as now contemplated will be from $200,000 to $300,000, including the amount of machinery that will be necessary over and above what can be transferred from the old works at the Woodward avenue railroad crossing. The plans and specifications are not yet complete, but they are expected to be finished so that work may be commenced in July and the works ready for operation by Jan. 1. The purchase of the property was completed only last week, and no time will be lost in erecting the new structures.

Extending down the middle of the property will be two railroad tracks connected at suitable points by cross-over switches. An overhead trolley system will be erected throughout the grounds, and electrical locomotives will be used for all shifting work. All buildings will be of fire-proof construction, and while not elaborate in design will be as little objectionable from an architectural standpoint in exterior appearances as strength and neatness will permit.

The present works are now running three hours overtime, besides employing the entire facilities of the Dry-Dock Engine Works in turning out the different mechanical parts of new equipment.

Louis Warfield, lately of the Pennsylvania Railroad Co., is now general manager and treasurer of the company. The other officers are: President, Hugh McMillan; vice-president, William A. Jackson; secretary, William H. Wells.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The Executive committee of the Association was exceedingly well received during its recent meeting in Montreal, and the interest shown in their proceedings is an excellent augury for the convention September 7, 8 and 9, as proposed. A strong local committee has been formed and is now at work. During their visit the N. E. L. A. representatives were most hospitably entertained. They were first welcomed by Mayor M. C. Shane and Alderman Stevenson, in behalf of the city, and ex-Mayor Beaugrand, in behalf of the French-Canadian population. Prof. Bovey stated that in all probability Lord Stanley would attend the meeting in September. In the afternoon the visitors, under guidance of Prof. Bovey, inspected the technical and electrical departments of McGill University. They were then taken to ex-Mayor Beaugrand's house, for refreshments; thence to call on Mayor McShane at the City Hall, and thence to the Mountain Summit. In the evening they were given a dinner at the Windsor Hotel by the Citizens' Committee, with Prof. Bovey in the chair. Among the speakers were Messrs. J. Kennedy, President Huntley, Beaugrand, Cox, Fairbanks, E. F. Peck, Corriveau, Villeneuve and Stevenson.

THE FRANKLIN EXPERIMENTAL CLUB.

At the thirty-third regular meeting of the Franklin Experimental Club, held at the club laboratory in Newark, N. J., on the 2nd inst., two papers were read. One was presented by Mr. Wm. J. Hammer and was entitled "Some Facts and Phenomena about Incandescent Lamps."

In the course of his paper Mr. Hammer showed that filaments of carbon are preferable to metals, as carbon is far more refractory and is of higher resistance. A vegetable or structural carbon is preferable to a homogenous carbon, as it is, first, mechanically stronger, just as a hollow column is stronger than a solid one; then the walls of vegetable cells are very thin and give a high resistance with a shorter length of carbon than is possible with a homogenous one. This is the reason why nearly all homogeneous carbon filaments are either curled or twisted, or, if straight, compel the use of exceptionally long globes.

Carbons after being placed in the globes are always "tempered" or "flashed," commencing with a small current and finally running up to several times the candle power at which the lamps will be run normally. This weeds out the poor filaments, and drives out the occluded gases in the carbon, clamp, and platinum wires in the lamps.

The vacuum in an incandescent lamp varies from one one-hundred thousandth to one-half millionth of an atmosphere. Generally it is even less than the former. Formerly it was supposed that too high a vacuum could not be attained, but it is now known that there is less strain and disintegration of the carbon and less blackening of the glass at lower vacuums.

At times one sees a lamp which burns much more dimly than others upon the same circuit and of the same rated candle power. This is probably due to a crack in the glass globe and the gradual admission of oxygen which is causing the carbon to be consumed. An evidence of this will be found in the exceedingly hot globe; also in the spotting of the carbon, which will become bright in spots and gradually waste away until it suddenly breaks at one of the bright spots. An incandescent lamp will last longer in a thin globe than in a thick one, as the heat rays pass through the thin glass and escape, while the thick one holds them and so lessens the life of the lamp. Incandescent lamps are longer lived on continuous than on alternating currents, the rapid reversals of the current shortening the life of the filaments. About 45 per cent. of the lamps in central stations are replaced before breaking, owing to blackening of the globes or to the carbons becoming too thin, thus giving less light.

Mr. Hammer believed that carbons would eventually be placed inside of dishes, cups, etc., electrically connected so as to keep their contents warmed.

The second paper was presented by Mr. Earl Atkinson, entitled, "Electric Motors." Mr. Atkinson first took up the subject in a general way, describing the more recent achievements and the present state of the art. He said that while the tendency was toward larger motors in some cases, in others it was toward a large number of small motors, as, for instance, in certain lines of manufactures where each machine was provided with its own separate motor. He then took up the questions more particularly involved in the design and construction of street car motors. These involve the questions of ability to endure, without injury, the great and sudden changes of load at starting, as well as to be run in either direction. Mr. Atkinson stated it as his opinion that when it becomes possible to provide street cars with satisfactory storage batteries connected to slow speed motors attached directly to the car axle, the resulting service will be all that can be desired.

NEW YORK ELECTRIC CLUB.

A smoking concert will given at the Club Thursday evening, June 18th, at eight o'clock. This is the first entertainment of the kind attempted by the Club, and it is believed that, the occasion will be a very enjoyable one. Members will contribute to the programme, which will include several original and novel productions. A business meeting of the Club will be held after the smoking concert.

Literature.

NEW BOOKS.

A Popular Lecture on Light. By Prof. Elihu Thomson, Lynn, Mass., *John W. Gibboney.* Pamphlet. Paper Cover. Price 20 cents.

Those who have had the pleasure of listening to Prof. Elihu Thomson in his exposé of scientific principles and their practical applications relating to matters electrical, will find in this little pamphlet the application of a method of treatment which has made him probably the model scientific lecturer of this country. While turning aside in this instance, somewhat from the work which lies nearest to his hand, Prof. Thomson is evidently at no disadvantage, and shows up especially the intimate relation which exists between electric phenomena and those of light, the lecture table having been equipped with a variety of electrical apparatus to demonstrate his remarks. Prof. Thomson begins by showing that we have ample proof that light is due to electrical vibrations of ether, and then passes in review the mode of propagation of light and its composition with regard to color. Then come the various methods of obtaining artificial light, passing from the primitive tallow dip to the most modern methods of electric illumination practiced to-day. Prof. Thomson also shows that if we could produce an alternating machine with a sufficiently large frequency of reversal, lamps would not be needed, as the whole machine itself and the wires proceeding from it would glow with light. He points out, however, the mechanical difficulties standing in the way of the production of a machine capable of giving such a large number of alternations. In conclusion, the lecturer dwells upon the cold light met with in the fire-fly and the Geissler tube. We can recommend the lecture as one which will absorb the attention of the reader throughout.

Arithmetic of Electricity. By T. O'Connor Sloane, Ph. D. New York, 1891. *Norman W. Henley & Co.* 138 pages, 5 x 7 inches. Price, $1.

THERE are many problems which occur in the construction of electrical apparatus, electric lighting and distribution of power which can be solved arithmetically, and a work which will enable those not fully equipped mathematically to perform these operations, therefore, has a distinct place in electrical literature. Our readers will recall a work of this character by R. E. Day, which appeared some ten years ago, and which deservedly met with general recognition. The work before us is based on the same lines, but the author has added much that will be found of value to those to whom algebraical formula are unintelligible. The plan upon which the book is based is to give first the rule in simple language, and then to follow it by an example showing the method of its application. In this way the author passes through the various applications of Ohm's law, the calculation of the resistance of conductors, potential differences, the area of wires to carry various currents, both for the two and three wire system, and the calculation of electrical work and energy, batteries, etc. To these are added a number of excellent rules on the construction of electro-magnets, dynamos and motors, in which are introduced the latest information on the subject, and referred to the C. G. S. system. Following the rules and examples the author has very wisely added a chapter in which he demonstrates the rules and gives the formula, together with the data, from which the rules are derived. The length of some of the rules given in the earlier part of the work would appear to have made it worth while to have introduced the formula at that time, simultaneously with the rule, in order to make its application clear. Thus, on page 44, we find a rule extending over six lines which it would be very difficult to apply in practice without the formula. To the contents just noted there has been added a series of tables with equivalents of units of work and energy, electrical resistance, thermo-electric equivalents, and various magnetic and electrical data.

While the book is not entirely free from errors, we believe that their nature is such as not to detract seriously from its undoubted value; but we hope that future editions may be more carefully proof-read. We can recommend the work to those seeking methods of direct application of principles to many problems met with in the electrical engineering of to-day.

MR. SPRAGUE'S CHALLENGE TO THE "NEW YORK SUN."

In the *Evening Post* of June 13 Mr. Frank J. Sprague, meeting the incredulity, affected or real, of the *New York Sun* as to the ability of an electric motor to haul a single elevated railroad car full of passengers at 30 miles an hour, made the following challenge:

> Let a section two miles long be provided on the Second Avenue, the Suburban or the New York and Northern Railway, which shall fairly represent a station section of the express track on the proposed underground road for use at night when not required for regular traffic.
>
> Set apart a train of six standard elevated cars. These will weigh when empty 71 tons, and can carry when crowded to the utmost about 500 passengers, weighing 37 tons, making a net weight of train without motive power of 108 tons.
>
> Let this loaded six-car train be propelled in two ways:
>
> (1.) By a separate electric locomotive.
>
> (2.) By a system of motors, one on each truck, all controlled from a pilot locomotive.
>
> Let the condition of operation be:
>
> (1.) A maximum speed of not less than 40 miles per hour on a level.
>
> (2.) Power to stop the train without the use of brake shoes and independently of the main station current.
>
> These requirements, both as to weight and speed, are double those now characterizing the operation of the London road, and represent a capacity of eight times that mentioned in the criticism.
>
> I will undertake to make this demonstration prior to the formation of a construction company, with free subsequent competition for regular equipment under either of these conditions:
>
> (1.) The Rapid Transit Commission to require the successful bidder for the franchise to pay the costs of the experiment to an amount not exceeding $50,000.
>
> (2.) The forfeiture of a like sum, in case I succeed within a specified time, by any person or newspaper that will take up my challenge.
>
> (3.) On the other hand, entire loss to me if I fail.
>
> (4.) The time to be four months from acceptance of this proposal, barring labor troubles, with one month leeway, at a forfeiture to me of $100 a day for each day of the month over the four months, and a premium of like amount for every day under four months. If the cost of the experiment shall be less than $50,000, the saving to go to the benefit of whoever pays for the demonstration.
>
> It will be noticed that this experiment is entirely at my personal risk, with time limitation, and without any direct pecuniary value to me, but is proposed to demonstrate the soundness of the decision made.
>
> As an evidence of my good faith, I am ready to deposit a sum which will guarantee the good faith of this proposal.

Reports of Companies.

THOMSON EUROPEAN ELECTRIC WELDING CO.

At the annual meeting of the Thomson European Electric Welding Company, at Portland Me., the following named directors were chosen: Oliver Ames, Benjamin F. Spinney, George P. Meserve, S. Endicott Peabody, Henry D. Hyde, Prentiss Cummings, Joseph N. Swett, Royal G. Robbins and Francis Peabody, jr.

WESTERN UNION TELEGRAPH CO.

The Directors of the Western Union have declared the regular quarterly dividend of 1¼ per cent. payable July 15. The statement for the quarter shows a decrease in net revenue of $250,000. For the fiscal year ending June 30 the net revenue over charges decreased $780,285 from the previous year, but was $162,324 in excess of the year to June 30, 1889. The surplus over dividends for the year was $1,274,996 against $1,408,978 to June 30, 1890, and $1,112,853 in 1889. It was officially stated that the company has 4,642 stockholders, the largest number in its history.

TROPICAL AMERICAN TELEPHONE CO.

The Tropical American Telephone Co., Limited, presents the following statement of assets and liabilities, as of date Jan. 1, 1891 · Assets—Bills receivable, $30,999.36; merchandise on hand, $11,400; treasury stock, 3,000 shares, $3,000; cash in bank, $8,232.14; total, $53.631.50. Liabilities—Bills payable, $2,505.39; balance, $51,126.11, or $1.25 per share. This balance is aside from patents, franchises and contracts. The capital of the company is $400,000, 37,000 shares issued, par value $10 each. The company's sales last year were rising $100,000, and the sales for the six months to Jan. 1, rising to $56,000. At the Jamaica Exposition the company was awarded a gold medal for its tropical telephone sets, both for long distance and for commercial uses.

ERIE TELEGRAPH AND TELEPHONE CO.

The annual meeting of the stockholders of the Erie Telegraph and Telephone Company was held last week in this city. The following officers were elected: Levi Sprague, president; Charles J. Glidden, secretary and treasurer; James P. McKinstry, general manager; and the following executive committee of the board; Abner S. Adams, Charles E. Adams, Charles J. Glidden, Wesley A. Gove, Francis Jewett, James W. C. Pickering, Asa C. Russell, Levi Sprague, James A Weston, and Harvey A. Whiting.

College Notes.

SCHOOL OF MINES, COLUMBIA COLLEGE.

The first class in electrical engineering graduated from Columbia College at commencement, June 10. The men to receive the new degree of electrical engineer (E. E.) are Gano S. Dunn, B. S.; Wm. H. Freedman, C. E.; Arthur S. Ives, C. E.; Joseph T. Monell, C. E., and Robert B. Owens. These men are post-graduate students, having all received a thorough collegiate education before taking the two years' course entirely devoted to electricel engineering work. This plan of first getting a thorough preparatory education and then concentrating the mind thus trained upon electrical work exclusively is found to give the most excellent results.

ELECTRIC HEADLIGHTS.

One of the lamps of the National Electric Headlight Co. is now in use, says the *Railroad Gazette*, on the Wilmington & Northern, where it has been running for several weeks. The use of this headlight is increasing in the West, and engines are now equiped with it on the Indianapolis, Decatur & Western; Vandalia; Cincinnati, Hamilton & Dayton; Columbus, Hocking Malley & Toledo; Louisville, New Albany & Chicago; Chicago & Eastern Illinois; Milwaukee, Lake Shore & Western, and the Wabash roads. Officers express great satisfaction with it, and the makers say that no engineer who has ever run behind one of these lights for any length of time, short or long, has failed to become enthusiastic in its praise.

ELECTRICAL EXECUTION.

The New York State Court of Appeals has denied the motion for a reargument in the case of the Japanese murderer, condemned to die by electrical execution, and has sharply criticised the resort to means of delay subverting the criminal law of the State.

SARGENT & LUNDY.

McIntosh, Seymour & Co., through their Western agents, Sargent & Lundy, 339 "The Rookery," have received orders for two 500 h. p. engines from the Chicago Edison Co,, to be used in increasing the capacity of their Adam street station. This makes nine of these engines, aggregating 2,650 h. p. now in use, which the Chicago Edison Co. have purchased for their central station work in this city from this firm. Sargent & Lundy have also received orders for a 150 h. p. compound engine for The Hyde Park Illuminating Co.'s new central station at Grand Crossing. It is very gratifying to note that so many of these high class engines are being installed in the West, where the excellence of their construction and service is highly appreciated.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of June 13, 1891, from New York, Boston and Washington:

NEW YORK.

	BID.		BID.
W. U. Tel. Co	80¼	Edison Gen. Elec. Co	99
American Tele. & Cable	....	Edison Gen. Co. Def'd	....
Centl. & So. Amer	135	Consol'd Elec. Lt. Co	...
Mexican	200	Edison Illn'g Co. N. Y.	76
Com. Cable Co	105	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	30	North Am. Phonograph	. ..

BOSTON.

	BID.		BID.
Thomson-Houston	42¼	Ft. Wayne Co	12
" Pref'd	25	Am. Bell	198
" Series C	....	Erie	48
" " D	7	New England	50
" Int. Co	....	Mexican	1.25
Thomson Welding Co.	....	Trop. American	.90
Thomson Eu. Welding	....	Edison Phon'gph Doll	.50

WASHINGTON.

	BID.		BID.
Penna. Telephone	24	U. S. Elec. Lt (Wash.)	155
Ches. & Pot. Telephone	62	Eck.&Sold. Home Elec. Ry.	42¼
Amer. Graphophone	5¼	Ge'rget'wn & Tennallyt'wn	57

PITTSBURGH.

Westinghouse El. & Mfg. Co.	12¾

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

SOME OBSERVATIONS ON THE EDISON LAMP PATENT.

AFTER nearly eight days of solid argument by an array of half a dozen of the most learned and able patent lawyers in the land, the great case of the Edison Electric Light Company against the United States Electric Lighting Company, involving the question of the validity and scope of Edison's principal patent for his incandescent electric lamp, has been submitted to Justice Wallace of the United States Circuit Court for decision. This patent has already passed through the ordeal of litigation in England and in Germany, but the present action is the first in this country in which it has come up for consideration on its merits, though some of the questions involved were to a certain extent passed upon in the suit of the Consolidated Company against the McKeesport Company on the Sawyer-Man patent, which came before Justice Bradley, at Pittsburgh, two years ago.

The aspects in which the present case presents itself are in some respects so peculiar, and they involve moreover so many abstruse questions, not only of equity, but of patent law and patent practice, that the ablest and most experienced lawyers and experts confess themselves exceedingly unwilling to hazard an opinion as to the ultimate outcome of the proceedings. That the industry of modern incandescent lighting is due to the genius and enterprise of Thomas A. Edison, aided by the moral and financial support which he received from the outset through the efforts of Grosvenor P. Lowrey, the eminent counsellor who has just advocated his cause before the court with such consummate ability, is no longer seriously questioned, even by his most determined opponents. That it is the intent of our patent law that the substantial rewards of invention should be of right conferred upon the person or persons to whom the public is justly indebted for the benefits it has received by reason of such invention, is a truism. If in the case at issue there were no other questions than these to be taken into consideration, the ultimate result could scarcely be open to doubt. But the statutes also require the inventor who seeks the protection of a patent to comply with certain well understood conditions, expressed and implied, and in the present case, as in many other important cases which have been heretofore submitted to the courts, it is just at this point that the difficulties arise. If a man buy a piece of real estate, and by reason of his ignorance or of the incompetence of his attorney, his title-deed is found to contain the description of some other property than the one he has bought; or if he fails to have his conveyance placed upon the public records, and is consequently forestalled by some subsequent purchaser who has exercised due diligence in that particular, the law is powerless to aid him. So in case of a patent; the statute requires that an invention shall be described "in such full, clear, concise and exact terms" that the public may be fully instructed how to practice the invention when the patent has expired; and furthermore, that the patentee "shall point out and distinctly claim the part, improvement or combination, which he claims as his invention or discovery," so that as long as the patent is in force, the public may be informed of the precise extent of the claim of the patentee, and may not innocently or ignorantly infringe his exclusive right.

The patent of Alexander Graham Bell for the speaking telephone affords a striking example of the impregnability of a patent, as a protection for an invention not only demonstrably novel, but of vast and unquestioned utility, the specification of which describes and claims in apt language the precise invention of the patentee—no more, no less. The entire description of the speaking telephone in Bell's specification does not exceed 150 words, while the claim is as brief as a claim well can be; but perhaps no patent ever granted in this or any other country has passed unscathed through such a fiery ordeal of litigation. The true explanation of the seeming good fortune which has attended this patent may be given almost in a word; its description and claim are precisely coextensive with the actual invention.

The conception of electric lighting by means of the incandescence of carbon conductors enclosed in a transparent vacuum chamber is nearly half a century old. In the New York *Evening Post*, of October 17, 1844, is an account of the Starr lamp, embodying all the features mentioned above, which afterwards made such a stir when patented in England, by King. The same idea in substance was in subsequent years revived in various forms by different inventors, yet in every instance it failed to attain the slightest commercial success. But the exhibition made by Edison at Menlo Park, in December, 1879, conclusively demonstrated to the world that an invention had finally been made, which, to use a hackneyed but expressive phrase, had "solved the problem of electric lighting by incandescence." What then, it becomes necessary to inquire, was the nature of that invention?

The claims of the patent of Mr. Edison, now the subject of litigation, set forth this invention as follows:—

> 1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth.
>
> 2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purpose set forth.

The expert witnesses who have testified in behalf of the Edison company, in the pending case appear to have substantially agreed in their definition of Edison's invention, as consisting of a filament of carbon, of high resistance and small radiating surface, sealed into an exhausted all-glass globe. Justice Bradley, in his opinion in the Sawyer-Man case expressed similar views. He says:—

> "It seems to us . . . . that the great discovery in the art was that of adopting high resistance in the conductor, with a small illuminating surface, and a corresponding diminution in the strength of the current. This was accomplished by Edison in his filamental thread-like conductors, rendered practicable by the perfection of the vacuum in the globe of the lamp. . . . In such a vacuum, the slender filaments of carbon, attenuated to the last degree of fineness, may be maintained in a state of incandescence, without deterioration, for an indefinite time, and with a small degree of electric force. *This was really the grand discovery in the art of electric lighting* without which it could not have become a practical art for the purposes of general use in houses and cities.

The general tenor of the arguments of the distinguished counsel who have represented the Edison interests in the pending case, have been based on a theory of the question at issue substantially the same as that held by Justice Bradley, namely:—"that the art of commercial electric lighting is founded upon the discovery and invention of Edison, and that this consisted in the employment of a filament of carbon of high resistance and small radiating surface, enclosed in a high vacuum. Undoubtedly the language in which the invention is attempted to be described and claimed, in the patent upon which the action has been brought, left the learned gentlemen no alternative but to take this position, and to the best of their ability to urge its acceptance upon the court, but it is nevertheless in point of fact, a question of no small moment, whether the claims of the patent are not based upon a complete, and possibly fatal misconception of the real character of the invention which it was intended to protect. Two circumstances which occurred during the trial at least tend strongly to support such a conclusion. One was the production, by the defendant, of a certified copy of an application from the files of the Patent Office, from which it appeared that Edison had attempted to procure a subsequent patent, defining the invention more accurately, and claiming it more broadly; urging at the same time that the claim of the existing patent (the one now in issue) was limited, and was wholly insufficient adequately to protect his rights. The other was the unavailing effort of the counsel for the defence to obtain, either from the witnesses or the counsel for the complainant, a definitive statement of the precise meaning of the terms "filament" and "high resistance," which form an essential part of Edison's claims. The question was met by dexterous and studiously evasive replies which in fact wholly failed to answer it. It was asked for example, whether a burner of four ohms resistance would be a "filament," and whether such a burner would be of "high resistance" or not, but not the slightest information on that point could be elicited. Now it is perfectly obvious that a burner of four ohms, or of half an ohm for that matter, might embody Edison's real invention, just as completely as one of a thousand ohms, and hence it would seem that the impossibility of satisfactorily answering the question could have been due only to the fact that the claim was not co-extensive with the actual invention, but covered nothing more than some of its incidental and non-essential features. If Edison's claim does not in truth define his invention in such a manner as to enable any person to determine with certainty whether he may or may not make an incandescent lamp with a burner of four ohms resistance or less, without being held liable as an infringer, then it must be null and void, for it clearly contravenes the express provision and purpose of the statute.

A careful consideration of the whole subject can scarcely fail to lead the thoughtful inquirer to the ultimate conclusion that the real invention which raised the incandescent electric lamp from a failure to a success, is to be looked for in the use of *a burner made of carbonizable material of cellular structure, which is first formed and then carbonized*. The real nature of the invention was therefore, to a certain extent recognized and expressed in the claims of the Sawyer-Man patent; but by the language employed in it was limited, first, to "fibrous," which is only one form of cellular carbon, and would therefore exclude, for example, a structureless material like Weston's tamidine, and second, to an "arch or loop for m," which, though usually preferable, is by no means an essential configuration for an electric burner. The modern lamp-carbon is a two-fold invention, a process and a product; just as the telephone is a two-fold invention, a method and an apparatus. Edison's merit therefore, did not consist merely in the engineering expedient of giving to a burner of known material, the capacity of high resistance and small radiating surface but in the adoption of a process and material essentially new, which enabled him to make his burners of any resistance, of any radiating surface, or of any ratio between the one and the other, and of such shape as to meet any possible requirement. To say that this most important invention consisted in nothing more than uniting high resistance with small radiating surface in a conductor, is to belittle it, and is no less absurd that it would be to assert that the invention of the electric telegraph consisted solely in winding the electro-magnet with a conductor of high resistance and many convolutions, because Morse's first apparatus, though fully capable of transmitting intelligence (just as the old electric incandescent lamps were of emitting light), was utterly useless as a practical or commercial instrument, because it would only work through a few feet of wire. The real invention in the case of the telegraph obviously lay in the application of the electro-magnet to the production of arbitrary symbols; the commercial success which came from the adoption of electro-magnets, properly adapted for use on a long line, was a mere matter of electrical engineering; were it otherwise, Henry or Gale, and not Morse, might claim to be regarded as the rightful inventor of the telegraph.

It may perhaps be fairly presumed that the underlying consideration which more than any other influenced the general result arrived at by Justice Bradley in the Sawyer-Man case, was that it is to the labors of Edison, rather than to those of Sawyer & Man that the world is indebted for the boon of incandescent lighting; and it is probable, that on the ground of abstract justice, few will be inclined to dissent from this conclusion. But even admitting this, it is by no means an unprecedented circumstance in legal annals, that a decision, right in itself, may have been reached by a chain of reasoning which fails to withstand critical examination.

With all deference to the views of so eminent a jurist as Justice Bradley, it would certainly seem as if in the case referred to, he might, with better reason, have put the dismissal of the bill of the complainant on the ground that the invention in issue, even if first conceived and experimentally used by Sawyer & Man, has become abandoned and lost to them through the superior diligence of their rival. The world might possibly have ultimately realized the benefits of incandescent lighting through the labors of Sawyer & Man, if no such person as Edison had ever existed, but the fact cannot be gainsaid, that Edison discovered, and so far as the record shows, independently and originally discoved, that the only way to make a successful incandescent lamp-burner, is to carbonize cellular material, and by previously shaping it, to confer upon it that amount of resistance and of radiating surface that might be requisite in any particular case; nor can it be gainsaid that all the incandescent lamps in use at the present moment are a direct result of that discovery or invention.

The courts have uniformly held that the claims of a patent ought to be construed with the utmost liberality permitted by the statute, in order to embrace and protect the invention actually made by a meritorious patentee. But at the same time the court cannot overlook the fact that the office of the claim, as prescribed by the statute, is to point out the precise boundaries and extent of the discovery which the patentee intends to claim as his exclusive property. As Justice Blatchford once observed, "If the claim is so ambiguous and uncertain that its true meaning cannot be made out without resorting to conjecture, or if it includes what is old, then the patent is void." It is just here that the difficulty is likely to arise in the case of the Edison patent. What, for example, are the qualities necessary to constitute a "filament"? Is it a matter of dimensions, or of proportions, or of form, or of structure? Neither the patent, the counsel, nor the scientific witnesses have found themselves able to formulate a definition. What is "high resistance"? Is it high specific resistance, or high total resistance? And by what standard is the height of resistance to be measured? These and many other questions which might be asked are by no means easy to answer, but evidently no such difficulty could have arisen, had the claims of the patent been so worded in the first place as to embrace the real invention which it was sought to protect.

The judgment of the court in this most important case will be awaited with great interest, not only on account of the character of the invention itself, but because of the vast commercial and pecuniary interests which are involved. Whether the patent of Edison will be sustained, and the defendants held to be infringers, thereby giving to the Edison Company, for years to come, the virtual control of the incandescent lamp industry, or whether it will share the fate of the Siemens and Gramme dynamo patents, the Brush single arc lamp patent, and the Gaulard & Gibbs alternate current patent, is a question fraught with important consequences to the future of the few prominent companies in whose hands the electric lighting industries of the country are now mainly concentrated.

BYSTANDER.

NEW YORK CITY,
June 12, 1891.

Legal Notes.

EDISON INCANDESCENT LAMP LITIGATION.—II.

ARGUMENT OF GEN. S. A. DUNCAN.

Upon the opening of Court on May, 28th, Gen. S. A. Duncan commenced his opening argument for the defendant. He said that he apprehended it might at the outset be well to get a clear conception of the problem which Mr. Edison undertook to solve in connection with electric lighting. Was that problem the mere invention of a lamp, or was it one of a broader and more complex nature, calling for invention not in one direction, but in a hundred? The bill of complaint had stated that Mr. Edison addressed himself to the work of inventing a complete system of electric lighting, capable of competing with other forms of illumination, adaptable to general use. It declared that this work necessitated the perfection of many distinct apparatuses; generators, conductors, instruments for regulating the quantity and pressure of the current, meters, lamps, sockets and holders, with many other accessory devices, the whole having been perfected only after many experiments, and frequently embodying distinct inventions. Mr. Edison was early in the field, after the great impulse in the domain of applied electricity which arose from the perfection of the dynamo machine; he had been backed by a powerful syndicate furnishing him with abundance of money, and the results of his labors in the solution of this complex problem are found in the large number of patents subsequently issued to him. In November, 1882, for instance, a circular issued by the Edison company gave a list of no less than 150 patents relating to this system, and many others followed in subsequent years. As early as 1883 the Edison Company were attaching to the packages in which their lamps were sent out, labels professing to indicate the lamp patents under which the company was licensed, 121 in number. Mr. Edison's own account of what he undertook to do, is as follows: "The problem then that I undertook to solve, was, stated generally, the production of the multifarious apparatus, methods and devices, each adapted for use with every other, and all forming a comprehensive system whereby electricity, properly controlled and directed, could de distributed over large areas, through the streets of a city, and supplied to houses in which it would feed incandescent electric lamps of moderate candle-power, which would be entirely under the control of the householder, the whole to be on the same scale as the present system of gas distribution, and affording the same character of convenience to the users."

But other inventors were at work upon this problem contemporaneously with Mr. Edison, and were as early in the field as he. Among them were gentlemen associated with the United States Electric Lighting Company, the defendant in this suit, which had a commercial plant in operation in New York as early as November, 1880, the first central station plant in this country. General Duncan thought he was correct in saying that according to the records no lamps were sold by the Edision Company in 1880, nor until after the organization of that plant by the defendant corporation.

Mr. Lowrey here stated that the manufacture of lamps was not carried on at that time by the Edison company, but by the Edison Lamp Company.

General Duncan, resuming, said that manufacture was begun by the United States Company that year, and that it had sold not less than 36,437 lamps to March 31, 1882, while the Edison Company to January 1, 1882, had sold but 34,597; this shows that those concerns, not to speak of others, were simultaneously at work upon this problem. The Edison Company had behind them as inventor Mr. Edison; the other company had other inventors; each had accumulated a large number of patents. Mr. Hebard says his company owned 131 patents in 1885. Yet the proposition of the Edison Company is, that a single one of the hundreds of patents it owns controls the situation, and through that one patent they propose to throttle this magnificent industry; the tens of millions of dollars invested by other companies is to be destroyed absolutely at the dictation of this company, under this one patent, which is only one of the elements in the general system. From that great mass of hundreds of patents, they single out this one, and say that it is that which solves the whole problem of the subdivision of the electric light. As to the interpretation of that patent, General Duncan said, he would take issue with his friends on the other side. His position was that it produced substantially no impression upon the art; he was willing to credit Mr. Edison whatever was his due by reason of the industry he had displayed, the persistence with which he had pursued the solution of the problem he had set before himself, and the large number of inventions he had made. But they were not now trying the value of any of the other inventions, but whether this one invention was the foundation of all Mr. Edison had done. In passing, he would remark that this was not the only suit pending in this court by this plaintiff agains this defendant; there were 29 other suits, involving a dozen other of the multitudinous patents of the Edison Company, and two or three of these were also styled fundamental patents. Probably if this suit should fail, the Edison Company would appear at final hearing at no distant date, declaring that the inventions patented in the patents there involved were the inventions that solved the problem of electric lighting; that was their position as declared in a New Jersey suit in which a patent for the distribution of current was involved, and in which a very intelligent expert called by the Edison Company, when asked whether the invention here in issue did not play an important part in the solution of the problem of subdivision had said: "Why, the lamp had something to do with the solution of the problem, but lamps enough were known to the world before the invention of Mr. Edison's carbon filament, which would have been good practical commercial lamps if only Mr. Edison's system of distribution had been known in the world, and when Mr. Edison invented that, he solved the problem of electric lighting."

Before examining the prior state of the art, Gen. Duncan said he desired to call the attention of the Court to one expression found in the patent as follows: "In general the attempts of previous persons have been to reduce the resistance of the carbon rod." This can mean but one thing; that previous experimentors or manufacturers of lamps undertook to reduce the specific resistance of the carbon burner, not the total resistance. It seemed to him important that that distinction should be kept sharply in mind throughout the whole discussion. After explaining the difference between specific and total resistance, Gen. Duncan said that most of the work in electric lighting prior to Edison's day had been in arc lighting, and the manufacturers of the pencils sought to make the specific resistance as low as possible in order not to waste energy in passing the current through the pencil. Such pencils were made by well-known processes for various purposes. They were made large and small, and were for sale in Paris and elsewhere; some as small as a millimetre in diameter. Undoubtedly King and Lodyguine, and later Sawyer and Man in their first experiments, purchased for their work on the incandescent lamp such carbons of low specific resistance. That was what this statement in the patent meant; it could not have been true in any other sense, for it was not true that any who were at work in incandescent lighting sought to reduce the total resistance of the burner to the lowest point. Such an interpretation would do violence to well-known laws of electricity familiar to all, and would be at variance with the plain teaching of all the patents illustrating the prior state of the art. If any man had undertaken to make electric lamps on the theory of reducing the total resistance of the burner to a minimum, he would quickly have found himself mistaken, however ignorant he might have been of the laws of electricity. That brought him to make a proposition, which he would suggest as a valuable one to carry through the discussion, and to explain many things which might otherwise seem confusing. High total resistance is, and has always been known as desirable for the burner of an incandescent lamp, whether to be used alone, in series, or in multiple arc. There was no mystery about it; the whole principle underlying the incandescent lamp is that of a continuous circuit traversed by the current. If one part of the circuit is of higher resistance than the rest, more heat is developed at that point; the higher the relative resistance, the more heat is developed, and the more light is obtained. It is wholly immaterial whether the circuit contains one lamp or fifty lamps in series, or fifty lamps in multiple arc. The term high resistance used in this art is a merely ralative term; it is high total resistance; the resistance of that part of the circuit in which useful work is done, as compared with the resistance of all the other parts. The essential thing in making an incandescent lamp is to interpose in the circuit at the point where the light is wanted, a resistance body whose total resistance shall be high relative to that of the other parts of the circuit, and the higher that ratio the more economical will be the performance.

In applying this established rule that high total resistance in the lamp is desirable in any case, certain limitations were met with, for example, in adding lamps in series, a point is ultimately reached requiring a current of so high electromotive force as to be dangerous to handle; but in the multiple arc arrangement, there being no increase of electromotive force, as in the case of the lamps in series, the resistance of the individual lamps may be made much higher. The principle can here safely be carried out to the uttermost, making the lamp of as high resistance as possible, but even then limitations were reached. One of them is that material cannot be manipulated to get an exceedingly high resistance, and yet keep down the radiating surface; but nothing in all that militated against the general proposition that from the beginning it had been a recognized principle that high total resistance was desirable, no matter how the lamp was to be used. A parallel case was that of Morse, who, although he had devised an apparatus for transmitting signals by electricity, sending impulses through the low resistance coil that surrounded his magnet, found that if this was placed near the battery his signals were recorded, but, if he interposed a long wire between the battery and his receiving instrument, he was not able to get a signal. Why? Simply because the resistance of his magnet, the working part of his circuit, was not high enough relatively to the other parts. Some one said "Put in one of Henry's high resistance magnets, with a large number of coils of very fine wire, making the resistance of that part of the circuit high relatively to the other parts, and thus concentrate the energy of the current at that point," and the work was done. If it is desired to do work of any kind, put a relatively high resistance at the point where the work is to be done. In that respect there is no mystery in electric lighting. It is on a par with all the other domains of applied electricity in which work is to be done. These principles were perfectly understood in applied electricity, and the man engaged in producing electric light in the year 1878 who had not applied those rules, would have written himself down as one not skilled in the art.

Gen. Duncan said he would next consider the prior state of the art, for it was only thus, of course, that it could be determined what the real invention was to which the claims of the patent relate. Of course it was desirable to ascertain Mr. Edison's date of invention. His own testimony seemed to be very explicit that it was October 21st, 1879. He would assume that this invention was not broadly for putting a carbon burner into a high vacuum, nor for a very slender burner in a high vacuum independent of the material, for these were old in the art. The question was, when did Mr. Edison invent the lamp which depends for its virtue upon that particular form of carbon to which he has given the undefined and undefinable name of "filament?" Not before the 21st of October, 1879. He then read extracts from Mr. Edison's testimony tending to confirm this assumption as to the date of the invention.

Gen. Duncan said that one of the first things to which he desired to call his honor's attention was the Geissler tube. In a general way the Geissler tube consisted of a hollow vessel of glass exhausted to a high vacuum; electrical conductors are passed into the tube and sealed by fusion (Several specimens of different forms of Geissler tubes were handed up to the court). He called attention to Mr. Edison's French patent of June, 1879, in which was illustrated and described an incandescent lamp, which was simply a Geissler tube. Mr. Edison, therefore, himself, recognized, as among the incandescent lamps of the world, a Geissler tube. This Geissler tube shows a receiver made entirely of glass, in the language of the second claim of the patent. It shows also fine platinum wires conducting the electric current into a highly exhausted chamber. These features of construction appeared elsewhere in other instruments that came into the art later than the Geissler tube. Faraday's *Chemical Manipulation*, published in 1831, describes, with great minuteness, how to manipulate the blow pipe, the wire and the glass, in order to accomplish this result. He would next consider briefly Crookes' radiometer, described in articles in the *Philosophical Transactions* of the Royal Society, from 1874 to 1878. One form of radiometer, described by Crookes, was the Edison lamp of the patent in suit, with the exception that they had not got, so far as he knew, the carbon filament. He did not know what the carbon filament was, but evidently it was not in this instrument, because there was no carbon. But there was the high vacuum, the all-glass globe, the fine platinum leading-in wires, and the burner inside. Now that was a lamp: not a lamp intended for general illumination, but for certain special uses. But it nevertheless embodied in its construction principles which Mr. Edison professes to have discovered and embodied in the lamp he devised for general purposes of illumination.

Gen. Duncan then referred to another part of Crookes' paper, from which he drew the conclusion that Crookes had found, that if in a chamber made of two pieces of glass, united by a mechanical joint, a high vacuum could not be maintained, fusion must be resorted to, and one part sealed to the other; so that it might be said the walls were made entirely of glass. He also referred to the testimony of Dr. Adams in the present case, as showing that he had employed the same expedient ten or twelve years before Edison began working in this direction. He would also call the attention of the Court to the record of the application for a patent in 1881 by one Freeman, in which the applicant showed an incandescent lamp having a carbon burner enclosed in an all-glass globe, highly exhausted, with platinum leading-in wires. Freeman was put into interference with this very patent of Edison; one reference cited against him was King's English patent. He then amended his claim to read as follows: "An electric lamp for giving light by incandescence, consisting of a strip or filament of carbon of high resistance enclosed within an exhausted receiver made entirely of glass, and attached to metal wires passing through, and sealed into the glass, as set forth." The Patent Office next cited as a reference Crookes' radiometer, and said: "It is not deemed material that applicant claims a carbon filament in place of the platinum conductor shown in the reference. *The substitution of one for the other being a matter within the skill of one well versed in matters pertaining to electric lighting*, it being old in the art to use carbon conductors for incandescing lamps." This action was reaffirmed on reconsideration, and the application finally rejected. Apparently this publication of Crookes was not known to the Patent Office when Mr. Edison's application was allowed. Certainly it would have been as pertinent a reference against Edison's application as against Freeman's. He would pass next to the consideration of the English patent of King, of 1845. This patent speaks of two kinds of lamps, one of a thin strip of platinum and one of a thin plate or small pencil of carbon. The patent goes on to describe how thin the platinum should be; so thin that by holding it before a printed page the letters could be read through it. So the word "thinness" with King, meant thinness, just as with his friends on the other side, a "filament" meant a filament; and that is about as far as they had got in the definition. It is a "filament" they tell us, because it is not a rod; and it is not a rod, they say, because you can see that it is not a rod. King goes on to say: "When carbon is used it becomes necessary, on account of the affinity this substance has for oxygen at high temperature, to exclude it from air and moisture. To accomplish this in the most perfect manner, it should be enclosed in a torricellian vacuum." Elsewhere he says: "As carbon will bear a very high temperature without fusion or volatilization, it may be employed when a very intense light is required." Here is a recognition, at this early day, of the superiority of carbon in this important particular over platinum. Again he says, "When the apparatus is *suitably sealed* it may be applied to submarine lighting, and also to the illumination of places where it is necessary to guard against the inclination of highly combustible or explosive compounds, as in powder magazines, mines, etc." The defendant's witnesses say that "suitably sealed" means that it must be sealed in such a way as to make it a portable instrument. Professor Brackett, who was brought forward to contest this view of defendant's experts, when asked whether it would require any invention to seal a platinum wire into the glass for the lower connection in the same manner as the upper wire, answered that it probably would not.

What were the things specially sought by the patent of King? These: That carbon had peculiar properties adapting it specially to use for the burners of incandescent lamps; the protection of the carbon from deterioration by enclosing it in the most perfect vacuum which could be made; the necessity of making the burner of very small cross-section in order to secure a high total resistance; and that when platinum wire passes through glass it is to be sealed in by fusion. Referring next to the Roberts-English patent, he stated that the patentee speaks of the burner as a piece of "very thin graphite," "as thin as can conveniently be made," and that "as perfect a vacuum as can conveniently be made must be obtained," and observes that "if the vacuum be perfect no combustion will ensue."

The next important thing was the Edison platinum lamp. Early in 1879 Edison produced a platinum lamp strikingly like the carbon lamp of the present patent. He made an application for a patent in the United States in April, 1879, and almost contemporaneously made application for foreign patents. The French patent issued in June, 1879; the American patent not until May 4, 1880, being therefore later than the patent in suit; but the invention had entered into the art before the making of the invention of the patent in suit, for it had been described in newspapers and crystalized in foreign patents. Handing a copy of the French patent to his Honor, Mr. Duncan pointed out that there was the highly exhausted glass chamber made entirely of glass with two platinum leading-in wires sealed into it by fusion, and connected in the exhausted chamber with a great length of very fine platinum wire coiled on to a bobbin. The American patent says that the function which high resistance plays, is "to enable a large number of lamps to be used in multiple arc," which his Honor would not forget was set forth by the plaintiff as an important feature of this discovery. Gen. Duncan then read a long extract from the French patent, and pointed out that therein was fully set forth the relation which should exist between the size and proportions of the burner of the incandescent lamp, and the quantity of material necessary to be used in the outside circuit for conveying the current to the lamp. What was true in relation to a lamp having a metallic burner was no less true in relation to a lamp having a carbon burner, and whenever Mr. Edison or Lane Fox, or anyone preceding them, had announced that principle, there could be no invention in subsequently applying it to lamps employing a different material for a burner. It became a mere question of electrical engineering. He understood the gentleman who opened for the plaintiff to put forth, as the great distinguishing feature of Edison's invention, that he was the first man to "appreciate" (that was the word he used, not once but a dozen times), he did not even say to "discover," but that he was the first man to "appeciate," at its full value, the relation that high resistance joined to small radiating surface sustained to economy of copper in the conductors. Therefore, he says, the patent in suit is to be sustained with a broad interpretation. "We say," said Gen. Duncan, "that that principle is old in the art." Edison knew it. He had given it to the world—perhaps supposing himself to be the discoverer of it—through various patents, long before he made the invention, which alone can be found in the patent in suit; months before "the great flood of sunlight came upon the art of incandescent lighting" (to borrow his own expression) he had not only described this thing, but had taken a patent for it.

A significant fact bearing upon this point is revealed by an examination of the proceedings in the Patent Office relating to this platinum lamp patent. When that application was filed, it contained this claim:

"In combination with a sealed vacuum chamber made entirely of glass a continuous incandescent *metallic* conductor as set forth."

After the allowance of the patent in suit, Mr. Edison substituted for the claim just read, this one with which this patent issued:

"In an electric lamp, the combination with a hermetically sealed vacuum chamber made entirely of glass, of metallic conductors passing through the glass and around which the glass is melted, and an *incandescent* conductor placed in the electric circuit, substantially as set forth."

The word "metallic" has disappeared from the incandescent metallic conductor of the original claim. That claim was broad enough to include all sorts of burners, whether made of metal or of carbon, or of any composition of matter; it was so intended. Prof. Barker testified that it is a broader claim than any claim of the patent in suit. Now, what was the meaning of it? After having secured the allowance of the patent in suit, they take this earlier application, elaborately setting forth the theory of the relation of high resistance plus small radiating surface to the wires of the circuit, and insert a broad claim that will cover both carbon and platinum lamps. If they have any patent on that subject matter it is No. 227,229, the platinum lamp patent and not the patent on the carbon burner. The full significance of that change was that whatever plaintiffs might think to-day, at that moment they could not have regarded the carbon patent as covering this principle of electrical engineering. It was not patentable at that date to any human being. It was as free as the air we breathe or the sunlight that beams upon us. His Honor might be interested to know why suit was not pressed on patent 227,229. That patent was in suit once, but was withdrawn by reason of a certain adjudication on the Bate patent in the Supreme Court. He supposed, at least, that that was the explanation, but at all events, that patent was originally made part of the subject of controversy in this cause; and the language of the bill glorifying Mr. Edison for his great work in this art is to be read in connection with that patent—wherein he has undertaken to patent a problem in electrical engineering—as well as in this one, in which he has coiled up a little piece of tar-putty, stuck it into a globe, and said "that is a great invention too." They might be met with the question whether the platinum lamp was a practical lamp. He did not feel called upon to answer that question, but was free to say that it had not obtained commercial use; it had quickly been followed by better lamps. Nobody questions that carbon is a better material than platinum. Mr. Edison and others had found that out, and it had been known beforehand. There was a difficulty in manipulating carbon to get a sufficiently high resistance. A wide field was open there for all inventors, and when one man found one method, and another another method, of taking carbon and bringing it into a filamentary form and having it stand, then lamps were made that were better than platinum lamps and that are in use to-day. The great field for invention then opened for the world was, how to make a burner that would satisfy the necessary engineering requirements. If Mr. Edison could make a high resistance carbon burner by rolling lampblack and tar into a fine wire and carbonizing it, he was entitled to a patent, if it was new. If it was better adapted for wide distribution by coiling it into a close spiral, for that also he might have been entitled to a patent. What he was contending for, however, was this great principle—which gentlemen propose to credit to Mr. Edison—of the relation between high resistance and small cross-section of the burner, and the amount of copper required to carry the current from the dynamo to the lamp, was not and could not be a part of the patent in suit. Gen. Duncan then cited the Khotinsky French patent of 1875 and the American patent of Woodward in 1876, as showing arrangements of incandescent lamps in multiple arc. He then passed to the consideration of the Lane-Fox patent and pointed out that it revealed, as fully as Edison's French patent, the relation between high resistance in the burner and the amount of copper required in the conductor.

Referring to the work of Sawyer and Man, Gen. Duncan said, that early in 1878 they were engaged in the development of a system of incandescent lighting; they operated with small carbons less than a millimetre in diameter, some of them but $\frac{1}{64}$ of an inch in diameter. The principal point in connection with them was, that the material was shaped before carbonization, and that they were exceedingly small—much smaller in cross-section than many of the commercial lamps of the present day. Summing up the prior state of the art, Gen. Duncan contended that the utility of carbon as an incandescent burner was well-known; so was the utility of the high vacuum to protect the carbon; so was the desirability of making the receiver entirely of glass; the use of fine leading-in wires of platinum; the arrangement of lamps in multiple arc; the necessity of giving the burner a high total resistance in order to secure wide distribution in multiple arc; the idea of making the burner of small cross-section; the manufacture of carbons by carbonizing a mixture of lampblack and tar. There were other things not explicitly described, perhaps not more than hinted at in these earlier patents and publications, which are found in Mr. Edison's patent, for instance, the securing the carbon burners to the leading wires by carbonizable plastic cement.

This appeared to be new with Mr. Edison. He had got a thing which he calls a "filament" but he had not defined it. He says it is so fragile it cannot be clamped; therefore he had to devise a new mode of securing it to the leading-in wires, and that seems to be one of the essential things of the filament. He also speaks of the filament as being made from carbon of high resistance. It is assumed from Edison's own testimony that that means a carbon that is purely structural. That is a carbon, the product of carbonization, made without subjecting it to any process that would reduce its specific resistance. The extreme importance of this distinction would be seen further on, for defendant's carbons are treated so that their specific resistance is vastly lower than that of purely structural carbon. In Edison's English patent, 3,765, of 1880, is found the following: "The practice, so far as known, has been to make them of as low resistance as possible, that is, low specific resistance—a porous carbon having been used which was dipped or soaked in some carbonizable liquid until its pores were filled, and then subjected to recarbonization, which process was repeated until the pores of the original carbon were filled with carbon. By this process the resistance of the carbon is lessened while its liability to disintegration under high heat is increased." Now, note that he says: "*Such carbons are unfit for use in electric lamps giving light by incandescence.* For such lamps, said Edison has discovered that the incandescing material should have the highest possible resistance in very small bulk, and be capable of resisting the disintegrating effects of very high heats and the absence of atmospheric pressure," and further that "*carbons which are purely structural in character alone possess these qualities.*" By "purely structural" is meant a carbon wherein the natural structure, cellular or otherwise, of the original material is preserved unaltered; that is, not modified by any treatment which tends to fill up the cells or pores with unstructural carbon, or to increase its density or to alter its resistance." Now, if that is the kind of carbon from which Mr. Edison in this patent proposes to make the burners of his lamps, they were not disposed to contest the novelty of his invention. Another possible feature of novelty disclosed in the patent in suit is the use of a carbon of a total resistance of 100 ohms. They did not think there was anything patentable in that, but stress seemed to be laid upon it in the patent. There were at least half a dozen statements in evidence by Mr. Edison, that at least 100 ohms were essential. It was assumed, therefore, that he intended to limit himself to that as a minimum; and so far as a carbon burner was concerned, that—for all that appears to the contrary in the record—was novel with Edison, even if not patentable. Another feature on which great stress was laid, the novelty of which they were not disposed to contest, was the coiling of the thing called a filament into a close spiral, so that only a portion of the external surface should have an active and efficient radiating surface. The prior state of the art did not show that this method of manufacturing the burner of an incandescent lamp had been resorted to. Mr. Edison dwells upon it with emphasis as performing a very important function. He was not asserting that it was patentable, but that it was the first time the thing had been distinctly announced. There had been a coiling of platinum, but it had not been stated that it was for the purpose of diminishing the radiating surface.

Certain points were formulated by Prof. Barker as important elements in the invention of the patent. He credits Edison with making a new departure in the art embracing the following features: (1) The carbon burner with small cross-section and small radiating service, even when of considerable length; (2) a filamentary burner of porous carbon of high resistance; (3) a filamentary burner first formed and then carbonized; (4) an all-glass bulb as distinguished from a separable chamber with cemented joints. As to the first feature, Gen. Duncan contended that it exhibited no invention. Prof. Cross says the value of the principle is wholly independent of the material of the burner, and had always been recognized in the case of platinum. He testifies that it is a mere application of the commonest principles of electrical engineering at that time familiar to those skilled in the art. His testimony is confirmed by Shallenberger, a graduate of the Naval Academy, competent by education and experience to pass upon the question, being familiar with the firing of torpedoes electrically by platinum fuses placed in multiple arc.

He would not say that the questions put to Edison on this subject had been dishonestly evaded, but they certainly had not been met in a frank and manly manner. It had been sought to search the conscience of this inventor; to know whether he really believed he had made a great discovery as to the relation existing between high resistance and small radiating surface and the amount of copper in the circuit. He hoped the court might find time to read every word of Mr. Edison's deposition when called as a witness for the defendant. He read among other extracts the following from Mr. Edison's testimony: *Q.* "Do you consider yourself the discoverer of that relation?" *A.* "I do not consider myself the discoverer of Ohm's law. It will explain all things that have been done and probably every thing that will be done in the next thousand years in electricity." *Q.* "I ask you whether you consider that you are the person who discovered the relation between the size and proportions of the burner and the character of the conductors conveying the current to each lamp, when being used in multiple arc?" *A.* "I do not know whether I am or not in relation to an incandescent lamp. Ohm's law does not mention incandescent lamps. It is a general law." So he went on, and presently began to quarrel again with Ohm's law: *Q.* "Didn't you know as a matter of inference from Ohm's law, that with a given size of conductor it would be necessary to give the individual lamps a higher resistance if they were to be used in multiple arc, than if they were to be used in series?" *A.* "It is not necessary in applying Ohm's law at all, but when you bring in the commercial element, then it is; *the fact of the matter is, that at the time I experimented on the incandescent lamp I did not understand Ohm's law.*" *Q.* "Do you mean that you did not know the formula of Ohm's law at that time?" *A.* "No, sir; I did not know it." *Q.* "When did you first get knowledge of Ohm's law?" *A.* "*It may seem strange for me to state that I do not understand Ohm's law to-day.*" *Q.* "I do not ask you whether you understand it, but when did you first know of it?" *A.* "I have heard of Ohm's law for the last twenty years." *Q.* "What do you mean by saying that you did not know Ohm's law at the time you began experimenting with incandescent lamps?" *A.* "*I mean to say that I did not understand Ohm's law. I do not understand it now and I do not want to understand it. It would prevent me from experimenting.*" *Q.* "Why?" *A.* "Because I would try to figure it out mathematically; *I have employed a great many mathematicians; they have all been dead failures.*" *Q.* "Does that include Mr. Upton?" *A.* "Yes, sir, in his mathematical capacity."

His Honor would see that they got no answer to their question. They had put Mr. Edison a fair question, intended to search his conscience, as to whether he believed he was the discoverer of that wonderful relation between the proportions of the burner, and the character of the circuit; the thing which formed the burden of the opening argument; the thing in which the great merit of this invention was supposed to consist, was this relation. They were fairly entitled to an answer to the question. But Mr. Edison flies into a quarrel with one of the great laws of nature; says that he does not understand it; doesn't know, nor want to know, what it is! Were they to believe that he, of all men, did not understand Ohm's law; one of the fundamental laws of electricity taught to children in primary schools? It was incredible. It was his method of avoiding an answer to that question; nothing more. It was a masterly performance in one aspect. When a knot was presented to Alexander which could not be untied, he cut it; so Mr. Edison evaded this question by a method not fair nor ingenious; it stands to-day on the record unanswered. There are other things betraying a similar real or assumed ignorance by Mr. Edison. Judging from his language, he honestly believed when he gave his testimony, that in 1879 he made for the first time the grand discovery that in an all-glass chamber, exhausted by a torricellian pump, a permanent high vacuum could be maintained. For the first time he came to know, what the rest of the world had known for a decade, that there was such a mechanism as a Sprengel pump, and he pats himself on the back, retires behind his own ignorance, and thinks he is a wonderful inventor! He takes his own ignorance as an understanding as to what constitutes invention! On the question of how much invention there was in proportioning the size of the burners and the copper in the circuit, the plaintiff's expert, Clarke, says there are no specific directions in the patent and none were necessary. When asked whether if all Mr. Edison had ever done had been to make, by the process described by the patent in suit, a single lamp, which had proved durable under test, it would have been the practical solution of the problem of the subdivision of the electric light, he answered yes; and why? Because persons skilled in the art would have at once known how to construct other lamps having burners properly proportioned for use in large numbers in multiple arc. Dr. Chandler has also expressed the opinion that mere engineering and mechanical skill was sufficient to adapt the old lamps to rendering them available for use in large numbers in multiple arc. Dr. Barker has said that an important feature of Edison's so-called "new departure" was in shaping the material for the burner before carbonization. But there was no novelty in that. Edison does it here with the plastic material. Carré and others had done that. Dr. Barker, on cross-examination, testified that he had done it himself in 1854. (At this point the court adjourned for the day.)

EDISON ELECTRIC RAILWAY SUIT AGAINST THE WEST END ROAD.

A special dispatch from Boston, of June 10, says:—"Two bills in equity were filed last Monday in the United States Circuit Court for the district of Massachusetts against the West End Street Railway Company, of this city, one by the Sprague Electric Railway and Motor Company and the other by the Edison General Electric Company, for alleged infringements of patents held and controlled by the plaintiff corporations.

"It is stated in the bills that the defendant has been guilty of the alleged infringements for some time past, one date being as far back as January, 1889, and the plaintiffs pray not only for an injunction, but for remuneration for past usage. An injunction will be asked to prevent the West End Company from using, first, the underground wire which is employed to connect the rail so that there may be a better conductor for the return current; second, to stop the use of guard wires; third, to practically prevent the use of trolley and feed wires; fourth, to prohibit the use of motors in parallel circuit, and last, to prevent the cutting of different sections of the line. These features are vital ones in all overhead electric railway systems, and without them cars could scarcely be run at all. If, therefore, the present injunction prayed for is granted, it will seriously affect a great many electric roads all over the country."

It is added in a later dispatch that the Thomson-Houston Co. will defend the suits. On inquiry, the patents referred to are stated to be the Edison patent 273,494, on conductor for reinforcing rails; the Edison "multiple arc" patent 369,280; the Sprague patent 317,235, combination of working conductors and feeders; Sprague patent 328,821, combination of two sets of working conductors with common source for each; and Sprague patent 338,313, working conductors divided into independent sections.

SYLLABUS OF THE OHIO DECISION IN FAVOR OF THE SINGLE TROLLEY.

The syllabus of the Ohio Supreme Court's decision in the case of the Cincinnati Inclined Plane Railway Co. vs. the City and Suburban Telegraph Association, adverse to the telephone and favorable to the electric street car interests, for the use of the ground for return currents, has now been given out, the full text being as follows, the opinion having been prepared by Judge Dickman:

1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street railways are by law authorized to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the rights of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city prior to the operation of an electric railway thereon will not give the telephone company, in the use of the streets, a right paramount to the easement of the public to adopt and use the best and most approved mode of travel thereon; and if the operation of the street railway by electricity as the motive power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of electro motive power upon the street railway.

3. Where a telephone company, under authority derived from the statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric current for the transmission of telephonic messages uses the earth, or what is known as the "ground circuit," for a return current of electricity; and where an electric street railway afterwards constructed on the same streets is operated with the "single trolley overhead system"—so called—of which the ground circuit is a constitutent part, if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground circuit as a part of the telephone system.

Judgment of the Superior Court at general and special term reversed and petition dismissed.

This decision was given in brief in the last issue of THE ELECTRICAL ENGINEER and commented upon editorially.

STORAGE BATTERY LITIGATION.

In spite of the steps towards a renewal before Judge Coxe of storage battery litigation last week, reports were current as to negotiations looking toward an understanding between the Brush and Electrical Accumulator interests.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 9, 1891.

Accumulators:—

Secondary Battery, W. W. Griscom, 453,695. Filed Dec. 10, 1887.
Consists, essentially, in enclosing the component parts—that is, the positive and negative elements—in a strong, closed chamber. The elements are in the form of masses of dough or paste. The vessel or chamber is divided by a porous diaphragm. The containing vessel is made of strength sufficient to withstand the pressure of the large quantities of gas generated. When the electrolyte is entirely decomposed the battery is operative as a gas battery.

Secondary Battery Element, J. H. Walter, 453,950. Filed Aug. 19, 1890.
Relates to the formation of electrode, which consists of a transversely corrugated metal tape wound or bent upon itself so as to present its edges outermost.

Secondary Battery, S. C. C. Currie, 453,995. Filed Jan. 31, 1891.
The electrode has a metal core or internal conducting body with an integral spongy or porous metallic surface and is inclosed in a covering of woven or braided fibrous material.

Alarms and Signals:—

Engine-Indicator for Steam Vessels, W. E. Hadlock, 453,696. Filed Nov. 14, 1889.
For indicating the movement of the engine and its direction to the pilot or captain of a vessel.

Electric Fire-Alarm, M. M. Braun, 453,723. Filed Feb. 17, 1891.
A thermostat, including a spring contact held open by an inflammable cord.

Fire-Alarm Telegraph, G. F. Milliken, 453 982. Filed Feb. 24, 1891.
A system including, with the usual district alarm boxes, auxiliary apparatus located in private dwellings, business offices, &c., for transmitting an alarm to a central station through the district boxes.

Non-Interference Signal Box, F. W. Cole, 453,993. Filed Feb. 7, 1891.
Relates to the class of non-interference apparatus which requires for its operation a closing of the signaling circuit of longer duration than the longest closing in any signal.

Conductors, Conduits and Insulators:—

Electric Conduit, J. E. Price, 453,733. Filed Jan. 7, 1891.
An underground conduit. A sectional conduit fitted with a lid closing the sections at the top, and capable of removal at any point for the inspection and repair of conductors.

Dynamos and Motors:—

Commutator, E. A. Sperry, 453,822. Filed Feb. 20, 1891.
The commutator contains an elastic medium to relieve the insulation from compression strains due to the expansion or contraction of the parts.

Commutator for Dynamo-Electric Generators and Motors, H. Davis and A. H. Stokes, 453,858. Filed Dec. 11, 1890.
Encloses the commutator bars and brushes in a surrounding atmosphere impregnated with gas to avoid danger of explosion from sparking and to protect the brushes from dust and the weather.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, J. O. Brinkerhoff and M. E. Smith, 453,898. Filed Nov. 26, 1890.
Employs an exciting fluid formed of antimonious chloride and an alkaline chloride.

Lamps and Appurtenances:—

Electric Switch, L. F. Furlong and F. O. Tucker, 453,633. Filed Oct. 24, 1890.
Adapted for incandescent lamp circuits. A quick-acting switch, the operation of which includes the insertion of insulating material between the contacts when separated.

Electric Arc Lamp, J. W. Ells, 453 693. Filed Mar. 21, 1890.
Relates to the class of arc lamps in which the light is produced between the peripheries of two carbon discs. The discs are located in planes perpendicular each to the other.

Manufacture of Incandescent Electric Lamps, R. A. Fessenden, 453,742. Filed Feb, 18, 1891.
Relates to the material of the leading-in wires and to sealing them in the glass bulb. Employs oxidizable leading-in conductors and exhausts the air from the globe before fusing the glass to the conductors.

Lighting of Tables and the like by Electricity, O. H. Stovell, 453,871. Filed Feb. 24, 1891.
Provides channels in the tops and legs of tables for conducting wires, and means for joining the latter to house conductors.

Measurement:—

Electrical Measuring Instrument, F. C. Wagner, 453,681. Filed Dec. 23, 1890.
Relates to the class of meters which utilize the heating effects of a current. Includes two substantially similar and equal wires fixed at their extremities, and mechanically connected transversly so as to act in opposition to each other.

Miscellaneous:—

Electric Cigar-Lighter, H. B. Brown, 453,618. Filed Dec. 5, 1890.

Billiard Table, L. A. Spaulding, 453,674. Filed Mar. 7, 1891.
Electric push-buttons arranged to respond to the weight of a ball.

Phonograph, T. A. Edison, 453,741. Filed July 30, 1890.

Distributing-Frame for Electric Conductors, A. S. Hibbard, 453,863. Filed Feb. 28, 1891.
For the disposition of connecting wires between the main conductors or cables leading to the streets from a telephone exchange and the office cables leading to the switch-board.

Electric Switch, W. Mitchell, 453,888. Filed Jan. 8, 1891.
Designed to provide means for extinguishing a spark or arc. Also provides means for combining the current from two sources at will in one circuit.

Railways and Appliances:—

Electric Railway, J. Jones, 453,710. Filed Jan. 15, 1891.
Relates to trolley-crossings.

Supporting and Connecting the Driving-Motors of Electric Cars, S. H. Short, 454,008. Filed Nov. 22, 1890.
Relates to the suspension from the car axles of a frame supporting the field-magnets of a motor or motors of which the armature or armatures are mounted on and connected directly with a driving axle.

Telephones and Apparatus:—

Attachment for Telephones, E. E. Baker, 453,722. Filed Feb. 17, 1891.
For supporting a writing tablet.

Metallic-Circuit Test and Time Signal for Telephone Exchanges, J. J. O'Connell, 454,016. Filed Oct. 4, 1888.
For determining whether a line called for at one section of a multiple switch-board is connected or in use at any other section.

MR. CHARLES G. ARMSTRONG, the consulting electrician of Adler & Sullivan, the well-known architects, is making plans for an arc and incandescent electric light plant for Wheaton, Ill.

TRADE NOTES AND NOVELTIES

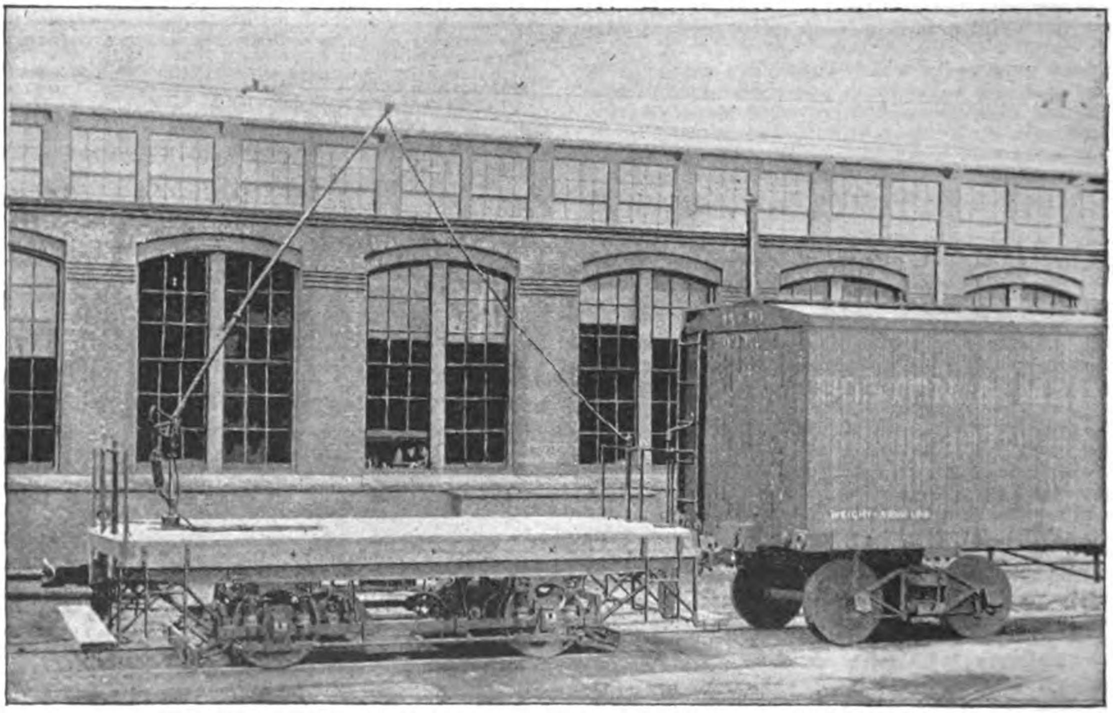
AND MECHANICAL DEPARTMENT.

Let your "ads." do the talking this hot weather.

THOMSON-HOUSTON ELECTRIC FREIGHT CAR.

THE accompanying illustration serves not only to illustrate the apparatus, but in addition proves that almost every day sees the production of some new type of electrical machinery adapted to mill work. The handling of both raw material and finished products of a mill is now rendered an easy matter by the use of the electric current There are but few of the largest mills that have not sufficient surplus power to operate an electric generator, the current from which, by the aid of electric motors, can be made to do certain classes of work much more satisfactorily and economically than can be accomplished in any other way.

The subject of the cut is one of the largest freight locomotives which has been constructed to operate by means of electricity. It was built by the Thomson-Houston Motor Co. of Boston, and is now in use at the cotton mills of the Lonsdale Co. at Lonsdale, R. I. As can be seen from the illustration, the locomotive consists of a platform car and truck equipped with a thirty horse-power Thomson-Houston motor. It is provided with a trolley stand and trolley at one end, and at each end with a controller stand by means of which the speed of the locomotive can be governed and its direction changed when necessary. The locomotive is capable of hauling a load of 60,000 pounds at the rate of five miles an hour. In addition to its use for haulage purposes, the locomotive platform, which measures eight by eighteen feet, may be loaded with material which it is desired to transport from place to place.



THOMSON-HOUSTON ELECTRIC FREIGHT CAR.

The total length of track over which the locomotive is used is 2,700 feet, on which the single overhead trolley system has been used, the wire being suspended over the centre of the track by means of brackets fastened to the buildings where possible, and to poles. The conductor varies in height from the ground between sixteen feet and eighteen feet. The necessary electric current for the operation of this tramway is obtained from a 500 volt Thomson-Houston dynamo of 30,000 watts capacity, which is driven from one of the water wheels which furnish power for the mill machinery.

MR. CHAS. D. SHAIN, general manager, eastern district, of the Edison Co., spent several days visiting his agency in Washington during last week.

DECORATIVE ARC LIGHTING.

Although the arc light has been in use a great many years, it cannot be said that it has developed as many features of beauty as of utility. At one time it was expected that the arc light would lend itself readily to schemes of decorative illumination, but such hopes have generally been disappointed, and but too often that which should have been a thing of beauty and a joy, has been a positive eyesore, either through the clumsy and ugly construction of the lamp or because while neat and trim at first the lamp has been allowed to become dirty and dilapidated. Yet there was nothing very much out of the way about those earlier hopes, and now the success attending the introduction of arc lamps on incandescent circuits leads us to believe that these optimistic views of the case will be amply justified. At any rate, the Universal Arc Lamp Co., of the Edison Building, Broad street, recognizing the great possibilities of the situation have, for some time past given their attention to this very matter, and they have already found that they have not overestimated the importance of the field or the urgency of the demand. They are now making a specialty of decorative arc lighting. In other words, not only do they offer and design ornamental arc lamps to go upon the incandescent circuits, but they also make such lamps in new and novel designs and finish, so as to harmonize with styles of architecture or with any kind of interior decorations and furnishings. A peculiar merit of the Universal lamp is that it can be hung at any angle without in any way losing efficiency, and will burn most successfully in positions that only an incandescent lamp had been supposed to be capable of assuming. The company is to be heartily congratulated upon this new departure, which is destined to give the public a very favorable idea of the flexibility and beauty of electrical methods of illumination.

After prolonged competitive tests in the New Jersey Central Depot, the Universal lamp has been finally accepted, and the company looks upon this result as a very good indication of the merit of its lamp. Another step forward is that made by the company in placing ten of its lamps in series across the circuit of one of the largest street railway companies. The steadiness of the lamps under such conditions was remarkable, and the successful trial seems to open up some large fields of use that had not before been comtemplated or, if considered, thought to be impracticable.

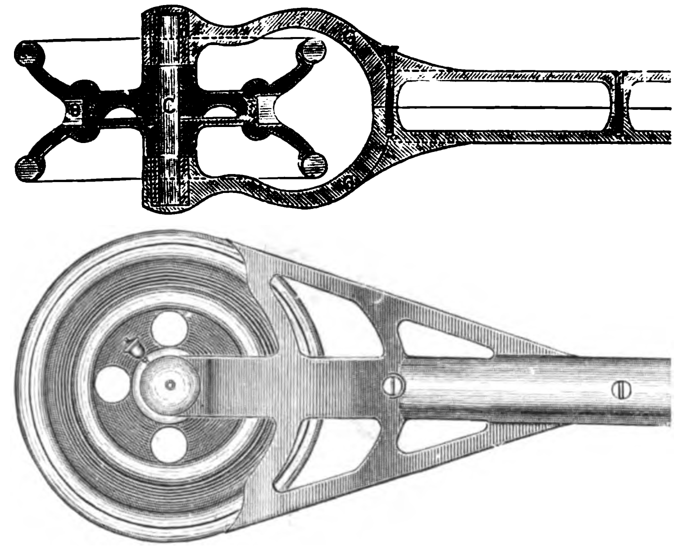
THE RUSSELL ELECTRICAL MFG. CO.

The above company, of Providence, R. I., will hereafter be conducted by Mess. Charles W. Russell and John Heathcote, Mr. John I. Drake having withdrawn from active interest in the concern. They now have large and excellent facilities for manufacturing, and will turn out more and better work than ever before. Mr. C. W. Russell is manager, and Mr. John Heathcote, who is a man of standing and means, is treasurer.

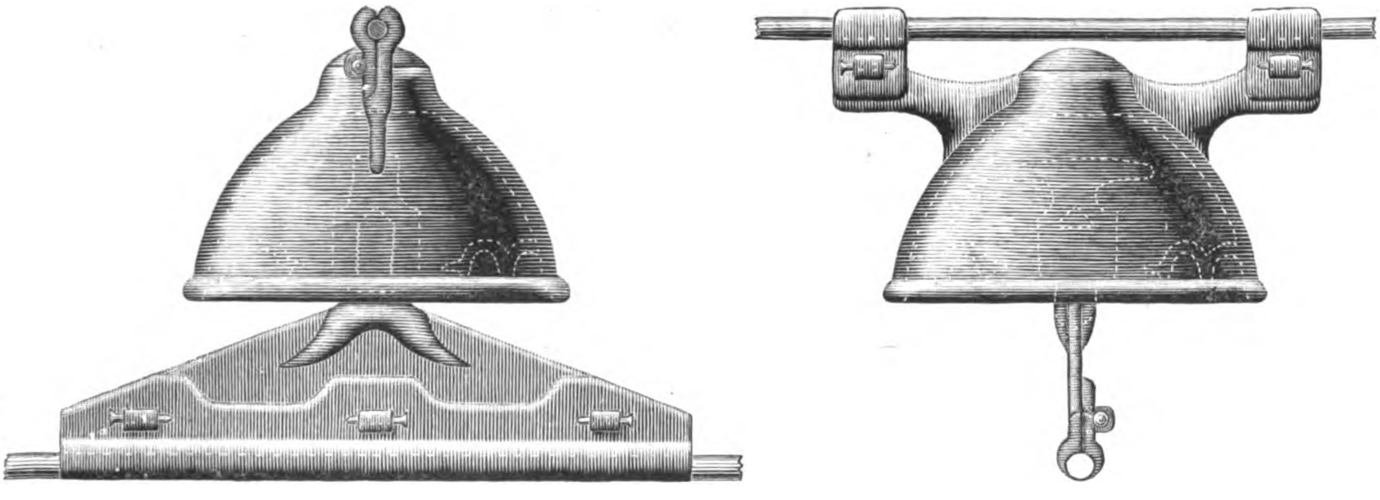
KIMBLE'S ELECTRIC RAILWAY APPLIANCES.

THE wide and constantly increasing field afforded by electric railway work, has led the Mica Asbetite Insulating Co., of Denver, Col., to give special attention to this branch of electrical industry.

The insulating material used by this company is a compound, of which atomized mica is the foundation, and which, while resisting both fire and water, is claimed to be unexcelled in durability.


FIGS. 1 AND 2.—KIMBLE'S SECTIONAL TROLLEY WHEEL.

In the accompanying illustrations, Figs. 1 and 2 represent a novel trolley wheel and holder. As will be seen, the pieces E and F screw together, firmly holding the centre wire bearing, B, which is quickly replaced when worn out. The wheel is firmly mounted on the centre shaft C, which runs in the removable bushing, D, and is lubricated by the oil cup seen in Fig. 2. The shape of the holder prevents the span wires from being caught and broken by the trolley, when jumping from the wire. The rubber tires, A, protect the insulated bells from being broken by the wheel. The holder is in two parts, G, G, fastened together by two screws, and holding all the parts securely in place.


FIGS. 3 AND 4.—KIMBLE'S INSULATED BELL AND COMBINATION CLAMP.

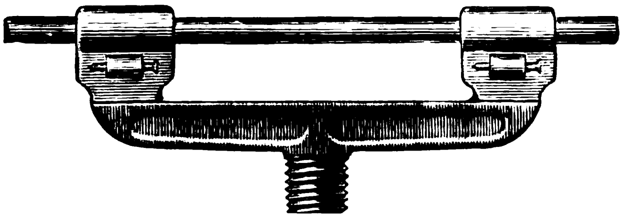


FIG. 5.—KIMBLE'S DETACHABLE CLAMP.

In Figs. 3 and 4 is shown the insulated bell and combination clamp. The insulating compound is hermetically sealed, and holds a button into which the clamp is screwed. The trolley wire is firmly gripped between the two pieces of the clamp, which are held together by three keys driven through the lugs. The clamp can be easily attached or removed by an ordinary tack hammer. In connection with the new form of bell, the clamp shown in Fig. 5 is used, and has the advantage of being easily and quickly detachable.

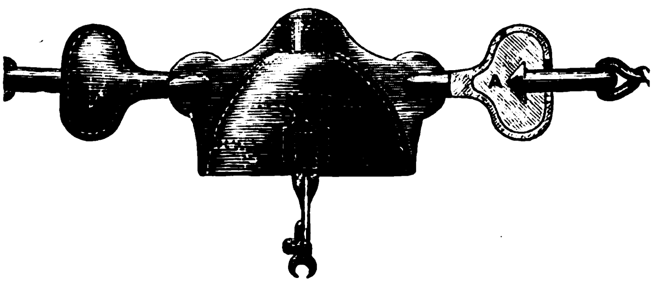


FIG. 6.—KIMBLE'S COMBINATION TROLLEY WIRE HANGER AND STAY.

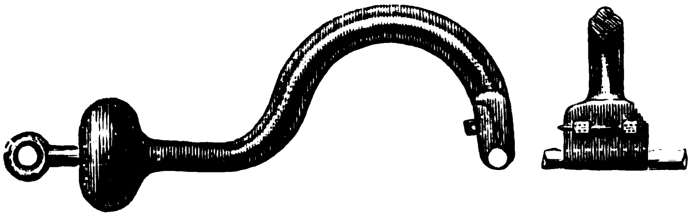


FIG. 7.—KIMBLE'S INSULATED PULL-OVER.

The combination trolley wire hanger and stay is shown in Fig. 6. The insulating hooks and bells are the same as used in staying wires on single track roads. This method combines the hangers and pull-overs in one arrangement, and also effects a double insulation.

Fig. 7 shows the insulated pull-over, or curve bracket. By this device the trolley wire is quickly fastened in place by driving a key through the lug. The button is held firmly by the insulating compound completely insulating the trolley wire.

BERLIN IRON BRIDGE CO.

The Companhia de Foejas e Estaleiros of Rio de Janeiro, Brazil, have placed the order for a large iron building, to be used in connection with their ship building plant, with the Berlin Iron Bridge Co., of East Berlin, Conn., and the order for the machinery with J. A. Fay & Co., of Cincinnati, Ohio. The building will be entirely of iron, 165 ft. wide by 300 ft. long, and will be shipped by steamer from this country, the parts being carefully marked so that it can be erected in place by native workmen at Rio de Janeiro. The Berlin Iron Bridge Co. are doing a large trade with the South American Republics, arising from the closer commercial relations.

PASS & SEYMOUR.

The demand for the porcelain goods of this house is so great that they have decided to increase their plant. In a letter to us, dated June 6, they say:

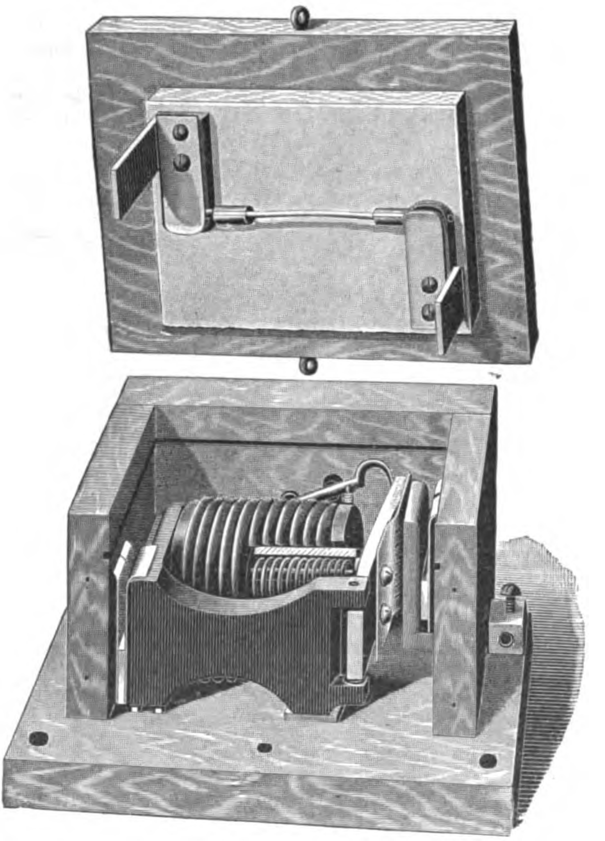
"The fact is, we are so crowded with work that we are doing very little with the line of supplies we intended manufacturing and placing on the market ourselves. Our standing orders are for more than 50,000 pieces per week, and we are actually furnishfrom 80 to 100,000 pieces every week, with telegrams coming in asking when we shall ship, and threatening to countermand unless immediately satisfied. We are contemplating an increase in our plant, which will be an absolute necessity even if our present business continues, to say nothing of an increase."

"We receive many inquiries through our card in your columns, and would not be without it if it cost as much again."

CUTTER'S MAGNETIC CUT-OUT.

ONE of the largest items of expense in many electric plants, and especially in railway systems is the cost of repairing or replacing burnt-out armatures and field coils. In motor cars the whole current may be thrown on before the armature gets up its normal speed, and the burning out of the coils is sure to follow unless there be some reliable safety device. Such a device should be accurately adjusted to open the circuit as soon as the current exceeds its safe limit.

This cannot be done with an ordinary fuse whose carrying capacity is sure to change after current has been passed through it for some time. But by combining a small fuse with a magnetic shunt, we get a device which is as sensitive as it is positive in its action. As the cut shows, the fuse has the current shunted around it through a magnet of low resistance. This is adjusted so as to cut itself out when the current becomes too strong. and send the whole of it through the small fuse. As the current may be ten time the capacity of the fuse, this is sure to blow and thus open the circuit. Another fuse can be quickly slipped into place without the use of any tools, and the cutout is then reset for action.

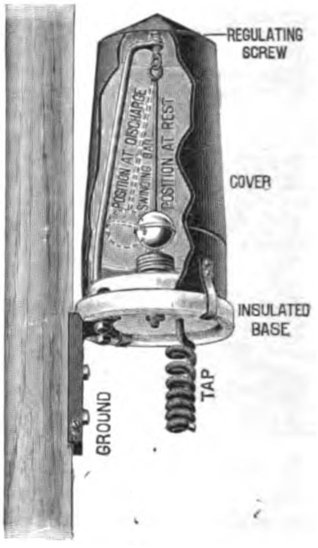


CUTTER'S MAGNETIC CUT-OUT.

The device is qnite simple and the cost of equipping a line with these cut-outs is often less than the price paid for armatures burnt out in a single day. For this reason railway men will be quick to see its merits and to protect their motors with such cut-outs. George Cutter, of Chicago, has developed it and will supply it to stations east and west.

THE SWINGING BALL LIGHTNING ARRESTER.

THE approach of the summer season, accompanied as it usually is by heavy thunder storms, renders it advisable for the central station manager to make provision for the thorough protection from lightning, of his lines and apparatus connected thereto. A lightning arrester, however, ought to embody in itself not only a simple method of carrying the discharge to earth, but ought to be of such design that it needs no attention whatever, so that it is ready to take a series of discharges in rapid succession, and "come up smiling" every time; a requirement which is frequently encountered in practice. To meet these conditions, Messrs. Treux & Vail, of the Electrical Exchange, this city, have just brought out a Swinging Ball Lightning Arrester, which is illustrated in the accompanying engraving. This arrester, it will be noted, is placed directly upon the pole, and connected to the line wire by means of the tap shown. The tap wire, it will be noted, is connected to a discharge terminal secured to the base of the arrester. Immediately above the discharge terminal will be noticed a ball which is suspended from a rod, and is thus free to swing in any direction. The rod suspending the ball is connected to the ground. From the above description it will be clear that a discharge coming from the line is led to the discharge plate by means of the tap, and as it jumps to the ball in its path to the ground, the ball is swung out by the arc to its full limit of swing, and the arc is thus automatically broken. As soon as the arc ceases, the ball returns to its original position and the apparatus is ready for another discharge. The instrument is evidently of the most simple character and requires no expert attention whatever. As an instance of its efficacy, we may note that the Boonton, N.J., Electric Light & Power Co. had, in the past, suffered to a very large extent from lightning, but since the use of the swinging arrester, some time ago, no trouble has been experienced from this source. The arrester has also been in use at Morristown and Elizabeth, N. J., with great success.



THE SWINGING BALL LIGHTNING ARRESTER.

"ISOLATINE" AS AN INSULATING MATERIAL.

There has been recently introduced into the market an insulating material, for which we predict a bright future, which has gradually attracted the attention of some of the best known authorities in the electrical line, notwithstanding the well-known difficulty which a new article of this kind encounters in trying to gain a foothold. The long felt want of a substance combining all the necessary qualities is claimed only now to have been overcome. These qualities are high insulation, flexibility, freedom from change by time and by cold or heat, unless the latter be artificial. Besides possessing the above named qualifications, it has the property of absolutely protecting metal. It therefore would find use in all underground and marine construction work.

It therefore becomes an article which all enterprising wire and cable, primary battery and accumulator manufacturers will investigate thoroughly and hail with delight.

The substance is known as Isolatine, and is brought into the market by the Roessler & Hasslacher Chemical Co. 73 Pine street, New York.

TUBING FOR HOUSE WIRES.

The increased safety secured by running all wires within building in tubes specially provided for that purpose is now so well recognized that their use is specified in the construction of most new buildings, while many with wires now run in moldings or embedded in plaster are being rearranged with tubes.

The manufacture of such tubing for house wires of all descriptions has recently been undertaken by the Eckert Electric Manufacturing Co., of 54 New street, this city, and the company have set a very high standard of excellence for their product. Thus they claim that their tube when held in the flame of a Bunsen burner or gas jet does not ignite and carry the flame, but merely chars, and hence is to all intents and purposes fire-proof. The tubes stand an insulation test of not less then one megohm with a current of 500 volts pressure. The tube is thoroughly moisture-proof and the insulating compound used is not affected by proximity to steam pipes where the temperature may range between 300 and 400 degrees Fahrenheit. Besides their employment for electric light, telegraph, telephone, and other house conductors the tubes are admirably adapted for speaking-tube purposes.

The President of the company, Mr. Wm. H. Eckert, is well known in electrical circles, having for thirty years past been prominently identified with the telegraph and telephone interests in this city.

THE BALL & WOOD CO.

The new plant of the Ball & Wood Company, at Elizabethport, N. J., promises to be a model in equipment and convenience for building the Improved Ball automatic cut-off engines. With a stretch of 900 feet between the main tracks of the Central Railroad of N. J. and Trumbull street, with the Singer Park at one end and the railroad station at the other, it is an ideal manufacturing site. The railroad sidings will serve, one the main machine shop into which it passes, and the other the foundry which, at present, is in contemplation.

From the City Hall in New York to the factory station is exactly ten miles, and a long distance telephone will connect these points, placing purchasers of engines in instant communication with the source of supply. In the main machine shop, even a wide awake engineer will be impressed with the mechanical progress made in the last decate. A glance will embrace an enormous room, light and airy, 70 feet high in the roof, and flanked with wide and substantial galleries sustained by iron columns. Overhead a Shaw electric crane will noiselessly raise a completed compound engine of twenty tons from the testing block, carry it the length of the shop, and place it on a car in readiness for shipment. On either hand are new and massive tools the latest product of shops both East and West, and throughout the entire establishment an air and order of system prevails, which, in itself, will guarantee substantial and excellent work.

It is the intention of the company to increase its plant by adding in length when it becomes necessary, and this can be done without interrupting the work in progress. A number of orders for the Improved Ball engines are already entered, and in another month the factory will be a busy scene, well worth the inspection of engineers as well as purchasers of this well-known engine.

EASTON ELECTRIC CO.

The Easton Electric Company, located at 45 Broadway, New York City, are the sole manufacturers of the Easton arc dynamos, new Universal arc lamp for arc and incandescent circuits, adapted to any dynamo, and the Easton incandescent dynamos, generators, motors, etc. Plants are installed at Rockland, Me.; Elmira, N. Y.; Lynchburg, Va.; Newark, N. J.; Brooklyn, Whitehall and Coney Island, N. Y.; Denver, Colo.; Chicago, Ill.; Milwaukee, Wis.; Burlington, Ia.; Reading, Pa.; Birmingham, Ala.; Milledgeville, Ga.; Eureka, Kan.; Lee, Mass., and Lakeland, Fla. Testimonials and endorsements of the highest character will be cheerfully furnished upon application. The factory of the company is in Brooklyn, N. Y., occupying two floors of a large substantial brick building on Kent avenue, between Keap and Hooper streets. The establishment is in charge of Mr. William D. Perry, vice-president of the company. Two Easton incandescent dynamos have just been sold; one of them, a 100 light incandescent machine, for the Brooklyn Annex Line, making three used on these boats, and a 250 light machine to go into the new Sound steamer "General Slocum."

The Easton Electric Company are now prepared to enter into an arrangement of a favorable character with a reliable and satisfactory concern, who will undertake the exclusive sale of the entire output of the factory for the United States, and they invite correspondence.

The Hide and Leather National Bank, a new institution lately organized, has elected as vice-president the well-known manufacturer of electric leather belting, Charles A. Schieren, of this city.

NEW YORK NOTES.

The National Electric Co. have been awarded the contract to install all the call bells, etc., at the Cumberland Gap Hotel, sanitarium and casino. The contract is for some 400 rooms, two complete watchmen's clocks, six large gravity drop annunciators, and a signaling apparatus with ten stations distant from the hotel; also a complete fire alarm apparatus.

Mr. Louis Walsh, of the Battery Department of Alexander, Barner & Chapin, reports sales so active that he had to suspend taking orders for the present until the batteries for which he has already received orders can be manufactured. This looks very well for the A. B. C. Battery.

Mr. Thomas Towne, the well-known buyer for E. E. Garvin & Co., has been confined for the last two weeks to his house very sick. He is, however, about again as usual and looks none the worse for his recent illness.

The Oneida Mfg. Co., Oneida, N. Y., are manufacturers of a patent improved drill chuck. Their little Hercules chuck has an unbroken bearing upon the drill shank the entire length of the jaw. The freedom from accident thereby afforded the drill shank together with the immovable hold of the jaws upon it, will in a short time effect a saving in drills sufficient to pay for the chuck. This becomes a matter of considerable interest to the electrical fraternity who will probably find it to their interest to look it up.

The American Electric Exercise Machine Company have taken a store at No. 25 East 14th street, this city, and have issued a "cordial invitation" to all their friends and others to inspect the machine at the above address.

Kolesch & Co., 155 Fulton street, this city, carry a full line of draughting room and engineering supplies. It is the headquarters for the supplies of several well-known electrical firms.

The Thomson Electric Welding Co. have opened an office recently in this city, in charge of Mr. F. B. Tracy, and now have a jobbing welding plant in full operation at the works of the Excelsior Electric Co., on Willoughby street, Brooklyn.

Himmer & Anderson have removed from 20 Vesey street to 128 Chambers street, where they will have increased space rendered necessary in order to keep up with the influx of business. At present they find it difficult to fill orders on hand, but propose to catch up.

PHILADELPHIA NOTES.

Mr. Wm. Hazelton, 3rd, of Philadelphia, has just issued a circular letter to his friends, advising them of his recently formed connection with the Continental Trust & Finance Company, of Philadelphia. Mr. Hazelton is organizing a new department in this company for the handling of electrical securities, which are day by day, as he points out in his circular, becoming of greater and more recognized value on the market. Electric railway and lighting companies will welcome the advent of a new company, or rather a new department of an old established company, to take care of their bonds, and we join Mr. Hazelton's many friends in wishing him well-deserved success.

Walker & Kepler have been awarded the contract for installing a plant for the lighting of the new Empire Theatre and Hotel Metropole, now in course of construction at Broad & Locust streets, this city. The plant will consist of four No. 90 Edison dynamos, and will be one of the most complete theatre plants in this country. The Interior Conduit & Insulation Company's system of tubing will be used throughout the work. The stage switchboard will be the Cushing patent of the most improved type, as illustrated not long ago in **The Electrical Engineer**. In connection with this work there will be used one of the new theatrical search lights, to take the place of the calcium light; also six arc lights for outside illumination. The building will be wired on the three-wire system, and the switches so arranged that either the current from the street or from the dynamo can be used.

Mr. Charles K. Westbrook, manager of the Isolated Light and Power department of the Thomson-Houston Electric Co., reports the following new installations:—Williamson Free School of Industrial Arts—1350 incandescents; Omnibus Company General—300 incandescent; Atlantic City Amusement Co.—300 incandescent and 25 arc; Croft & Allen—250 incandescent; M. R. Muckle & Co.—35 h.p. motors besides several other plants of less note.

The Equitable Engineering and Construction Co., of this city, has the contract to build an electric railway of the "Rae" system for the Athens (Ga.) Electric Railway Company. They are also building a three mile road for the Highland Park Electric Railway Co., of Richmond, Va., which will be operated for a time in connection with the Richmond and Manchester Railway.

Baltimore. The Southern Electric Co. have contracts to equip the Hebrew Temple and the Phenix and Maryland Club Buildings with tubing of the Interior Conduit system.

W. S. Griffith & Co. have just put in operation the four 100 h. p. Mather generators recently installed for the Suburban Rapid Transit Co. at Pittsburgh, Pa.

Mr. Leonard Atwood is the new general manager of the Wenstrom Consolidated Dynamo and Motor Co., of Baltimore, Md., and things are going with a vim and briskness that is perfectly exhilarating. Mr. Atwood was formerly mechanical engineer for Chadbourne, Hazelton & Co., and previously with Stokes & Parrish for five years. This has been an excellent training, and Mr. Atwood fits into his new work as to the manner born. He has the enormous advantage, moreover, of being a thorough mechanic, and thus not only can keep things going, but knows whether the output of the factory is being kept up to a high standard. The Wenstrom Co. are now getting a splendid headway.

WESTERN TRADE NOTES.

The Illinois Electric Material Co. during the past week in their electric street railway department, which is presided over by Mr. E. L. Clark, Secretary of the company, have closed contracts for the line supplies and equipment of 18 miles of road.

Mr. W. R. Mason, the manager of the Electric Merchandise Co. of Chicago, has returned from a short but highly successful trip, during which he obtained some large orders for street railway equipments and supplies.

Mr. Geo. C. DuBois, general inspector of the Interior Conduit and Insulation Co., of New York, was a Chicago visitor last week. This well-known system is finding great favor in the West among architects and builders, and this success is largely due to the energetic work of Mr. H. M. Underwood, the general Western agent of the company, who is introducing the system very largely in this part of the country.

Mr. I. Lincoln, Auditorium Building, Chicago, has made specifications for the complete mechanical outfit of the proposed new German Theatre Building in Chicago.

Mr. Hood, the well-known dealer in electrical specialties at 239 Lasalle street, has just taken the agency of the "Jewel" incandescent lamp, and is now handling these lamps in large quantities. They are giving excellent satisfaction, and combine long life without discoloration, with high efficiency and durability. Mr. Hood has also secured the agency of the Mosher arc lamp for incandescent circuits, and is selling quite a number of these popular lamps.

Mr. E. E. Keller, so well known among the electrical fraternity as the manager of the Chicago office of the North American Construction Co. up to the time of their retiring from business, has associated himself with the Fort Wayne Electric Company with headquarters in this city. The Fort Wayne Co. and Mr. Keller are to be congratulated on the new arrangement.

The McGuire Manufacturing Co., manufacturers of the famous Hubbard trucks, are very busy, and their works are pushed to their utmost capacity. Among their recent orders are East Harrisburg Passenger Railway Co., 20 new steel trucks for the Brill car bodies; Sioux City Railway Co., all their trucks; Toledo Street Railway Co., 28 trucks, this being a second order, making 48 trucks in all; Little Rock, Ark., 28 trucks; Worcester & Spencer Street Railway Co., Worcester, Mass., 10 trucks; Galveston City Railway Co., Galveston, Tex., 10 trucks; Lawrence, Mass., 15 trucks; Milwaukee, Wis., 129 trucks; Cicero & Proviso Street Railway Co., Chicago, Ill., a second order of 24 double trucks; Aurora, Ill., 15 trucks; West Superior, Wis., 10 trucks, and they also have shipped trucks to Springfield, O., Salt Lake, Utah, Omaha, Athens, Ga., Grand Rapids, and Salem, Mass. Their trucks are now in use under the car bodies of almost all the manufacturers, and are giving perfect satisfaction.

Mr. J. R. Burdick, the representative of the H. W. Johns Manufacturing Co., of New York, dropped in at the Western office of **The Electrical Engineer** last week.

ST. LOUIS TRADE NOTES.

Mr. L. W. Arnold, the St. Louis agent for the Thomson Houston Electric Company, has secured a contract for a 3,000 light installation for the Carondelet Electric Light and Power Company, South St. Louis. Three alternators of 1,300, 1,000, and 650 light capacity respectively will be installed at present. The Thomson-Houston Company will do all construction work up to the converters, and the local company will do the secondary wiring. Mr. Arnold has also secured a contract for 3,000 lights for the new Wainwright Building, now being erected at the corner of Seventh and Chestnut Streets; also 18 arc lights for the Rankin & Fritz Machine Co.

Mr. Guido Pantaleoni, Western representative of the Westinghouse Electric Co., reports the sale of electric railway equipments at Salina, Kan., 5 cars and 2 60 h. p. generators; Cairo, Ill., 4 cars and 1 80 h. p. generator; Marion, Ind., 4 cars and 2 80 h. p. generators.

Mr. B. M. Barr, St. Louis agent for the Edison General Electric Company, has removed to Cleveland to conduct the Cleveland agency of the company. Through Mr. Barr the Edison General Co. have lately taken contracts for the wiring for 3,000 lights in the new Security Building, corner Fourth and Locust Streets. The wiring will be laid in "interior conduits." Also 1,000 arc lights for the Consumers' Electric Light and Power Co.

The National Electric Manufacturing Co., of Eau Claire, Wis., have, through their St. Paul representative, Mr. C. A. Daigh, secured a contract for 10,000 lights for the Consumers' Electric Light and Power Co.

The New Meston Alternating Current Fan Motor of the Emerson Electric Manufacturing Co. is meeting with great success. Their factory is working night and day to keep up with their orders, and owing to the overcrowded condition of their factory they have been compelled to open up factory No. 2 across the street.

The St. Louis Electric Supply Co. have removed to 809 Locust Street, where they have more commodious and comfortable quarters. Mr. Scott, President of the company, reports a steady business in all lines of their goods.

The Western Electrical Supply Co. have removed to 619 Locust Street. The company has lately been reorganized, Mr. Chas. Scudder is President, R. V. Scudder, Sec. and Treas., and T. J. Wilson, Vice-President and Manager. Their new quarters are commodious and well located for their prosperous business.

The Underground Electric Traction Company of Mo. has been incorporated with a capital stock of $100,000 for the purpose of developing and promoting underground electric traction devices invented by Messrs. Murname and Sheldon. The officers of the company are David J. Murname, President; Jos. B. Sheldon, Vice-President; G. L. VanBeek, Secretary, and Jas. M. O'Shea, Treasurer.

Mr. B. J. Arnold, consulting engineer of the Western Office of the Thomson-Houston Co., Chicago, was in town this week on his way home from Little Rock, where he has been engaged in planning a 2,000 h. p. station for the City Electric Street Railway Co., Little Rock. The installation will include compound condensing engines, Heine safety boilers, and at present 5 100 h. p. Thomson-Houston railway generators. The rolling-stock equipment will consist of 28 cars, fitted with the new single reduction gear motors. The power station will cost about $95,000.

The St. Louis Electric Power Co. have added an 80,000-watt Edison generator to their power station; also a Russell engine of 150 h. p., two 150 h. p. plain tubular boilers and a Berryman heater. The company have taken the agency for the Eddy Motor Co. and have put in some 15 motors of that type, ranging from 1 to 10 h. p. The arc lighting business of the company has proven very successful from the start.

Mr. P. H. Broughton, a Cornell University man of '90, has joined the forces of the Municipal Electric Light and Power Company, as assistant to Mr. Ayer, the general manager.

WASHINGTON NOTES.

Mr. Geo. W. Silsby has sold an Edison R. R. plant to Raleigh, N. C. Five miles of single track and light car equipments will be used.

The Washington & Arlington R. R., of this city, have opened their subscription books, and are fast finding investors. This is the road which will eventually run to Mt. Vernon, the home of Washington. They are to reach this city by means of a new bridge over the Potomac.

The Washington & Tennallytown R. R. have recently purchased two new generators from the Thomson-Houston Co. They are 150 and 200 h. p. respectively.

Mr. Coldgate, of the Thomson-Houston Co., was in town for a few days this week. He reports business throughout the State of Virginia as exceedingly brisk this summer.

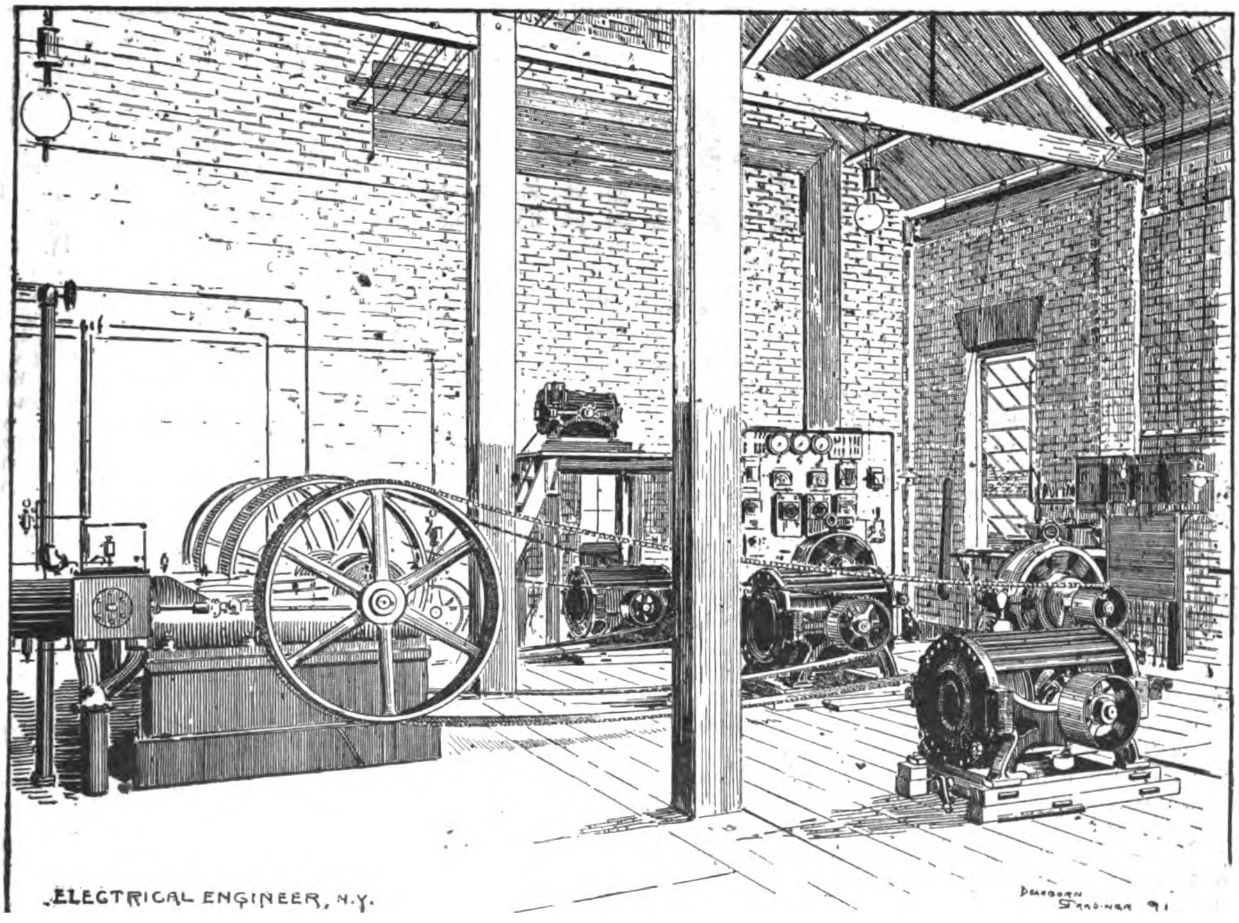
☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

Vol. XI. JUNE 24, 1891. No. 164.

KINGSTON ELECTRIC LIGHT PLANT, JAMAICA, W. I.

RECENT experience with hot weather enables all of us to form an excellent idea of the benefits that the electric light confers upon the dwellers in the tropics. Oil lighting and gas lighting are both of them accompanied by many objections in climates where it is no advantage to use methods that combine the lamp and the stove in one piece. Even in moderately warm regions the added heat from oil lamps or gas jets is more than one can steadily endure, and hence we need not wonder at the habit of dwellers in the tropics of sitting for hours in the dark in the open air. There are now very few parts of the globe ignorant of the merits of electricity in furnishing a brilliant light with the minimum of heat, and without smell or fumes injurious to furniture, and hence also we need not be surprised at the rapid introduction of the electric light in places where it is calculated to do the most good. Nor, perhaps, need we be surprised that American apparatus is largely in demand for this special class of work.

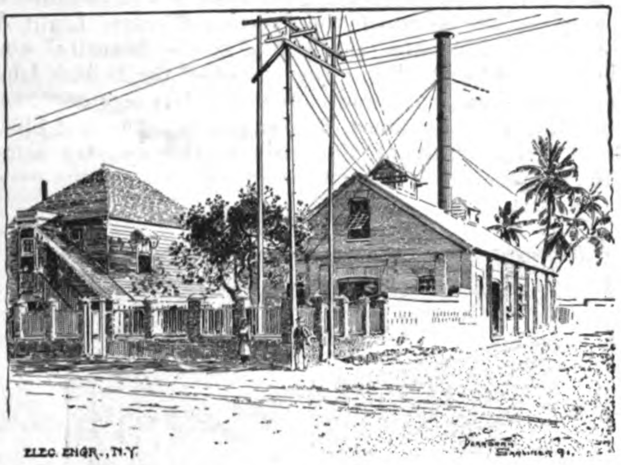


Dynamo Room, Kingston Electric Light Plant, Jamaica, W. I.

A noteworthy exemplification of the success that can be attained in the tropics with a good system well installed is furnished by the plant of the Jamaica Electric Light & Power Co., at Kingston, the capital of the beautiful and productive island which has long supplied the British Isles with choice sugar, rum and coffee, and has now captured our market with the finest of oranges, bananas and pineapples. As a result of the visit to this country some months ago, and of investigations in which it was the good fortune of The Electrical Engineer to assist, it was decided by the new company to buy a plant of American make; and the choice finally fell upon the apparatus of the Thomson-Houston Co., of Boston. A plant was shipped in charge of Mr. G. Montagu White, as engineer-in-chief of construction, and in a very short time the fine station and offices, of which we here show a couple of illustrations, went into successful operation.

The dynamo room seen in Fig. 1 contains two 650 light machines of the alternating system, separately excited, running at 1,000 volts; a 300 light, 110 volts, direct current machine; one 50 light arc machine, one 30, one 9, and one 4. The steam plant at present installed consists of one 120 h. p. McIntosh & Seymour compound condensing engine and one 80 h. p.; with two 125 h. p. multitubular boilers, which are set on the Jarvis plan. The steam plant includes also the latest and most improved condensing apparatus, feed-water heater, purifiers, etc.

At the time the report was made on the plant, accompanying the photographs sent us, the incandescent machines were supplying current to 1,836 lights, but the lighting was of such a mixed character that the load had not exceeded 60 amperes. Orders have been pouring in daily, and the company now intend to add another 650 lighter with a 150 h. p. McIntosh & Seymour engine. Hitherto the dynamos have been run belted direct to the engines, but this arrangement is being altered, countershafting in three sections for the three engines connected by Hill friction clutches being used, and all the dynamos will be run by the Evans friction system. In this way a mechanical combination will be effected equal to a duplication of the old arrangement. The arc machines were carrying a load of 72 lamps.


ELEC. ENGR., N.Y.

KINGSTON, JAMAICA, ELECTRIC LIGHT STATION AND OFFICES.

The company, as will be seen, is already doing a satisfactory business, with the prospect of rapid growth. It deserves mention that the company was able to render valuable service in assisting to light up the recent Exhibition. An English concern that had contracted for lighting the Exhibition was unable to live up to its contract, whereupon the local company was asked for help, and was able to afford it in a very substantial manner.

The construction work of the company has been of the solid, lasting kind, and the street circuits are therefore in excellent shape. Simplex wire was used throughout, so that in every particular the plant is American, a fact that does not lose in significance because Jamaica is a British colony. Whatever may be the political ties of the island, there can be no question that her commercial relations with America become more and more friendly; and it is certainly to the interest of the American electrical industries that this intimacy with so progressive a colony should continue.

THE CASSEL ELECTRO-CHLORINATION PROCESS IN NEW ZEALAND.

According to *Industries*, the Crown Mines Company of New Zealand, a Glasgow enterprise, has made a successful trial of the Cassel electro-chlorination process. A crushing of 263 tons of ore yielded 90½ per cent. of the assayed gold, and 70½ per cent. of the silver. The value of the product was $30.25 per ton of ore, as against $9.75 per ton by the old battery method. The cost of the extraction is set down by the Crown Mines Company as follows: Drying, 36 cents per ton; grinding, $1.22 per ton; cost of Cassel process, $3.16—total $4.86.

FASTENING CIRCUIT WIRES TO ARC LAMPS.

BY

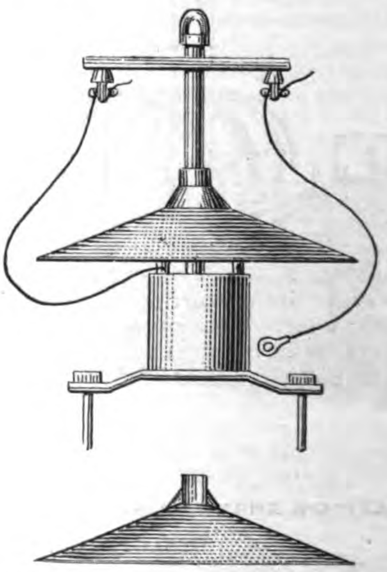
S. H. Sharpsteen

THE president of an electric light company once asked the writer if he was ever bothered with wires coming out of binding posts of arc lamps, and circuits breaking off near the spreaders of lamps that were suspended over the streets and had to be lowered to be trimmed. On informing him that precautions were taken to prevent such accidents he wanted to know what they were.

In the first place our trimmers were instructed to take hold of the lamp wires and wriggle them to see if they were loose, but one asks if that is not a good way to loosen the wires. With the lamps as they used to be made, that is just what a trimmer would do unless he was accustomed to the business. From long experience the writer thinks that for arc lamps in stores, in front of buildings, and suspended over streets the wires should be continuous right into the lamp, not terminating in a hanger-board and from thence to the lamp.

When a lamp is to be put in front of a store, the outrigger or support, hood, and lamp should be as simple and as neat as possibe. Four years ago experience suggested the following to the writer, which was put into practice and found to be very good:

For all outside arc lamps, except those that were put on top of poles under larger hoods, the lamps were arranged as shown in the accompanying engraving. The local tinsmith got us out hoods of galvanized iron, the weight of which we left to his judgment; some were light with wire around edge; others were heavy enough to do without the wire, like the one illustrated, which is twenty-one inches across, with a sleeve at the centre $\frac{3}{32}$ of an inch larger than the horn of the lamp. After the spreader was put on the lamp horn, the hood was put up as far as it would go, and then the horn was wound with insulating tape until the cylinder in the centre of hood would just come down to the position the hood should have on the horn. If the tape is put on properly the hood will fit very snugly. The tape should extend up the horn far enough so that it will project through the sleeve, and the tape should be wound around the top of the sleeve and over on to the tape on the horn.



FASTENING CIRCUIT WIRES TO ARC LAMPS.

If a little care is taken, the hood will be firm on the lamp, water-tight, easily removed, and saves much trouble and expense in soldering. As regards the spreader, it should be made by a carpenter out of good, firm wood 1¼ inch thick. The other dimensions will depend on the size of the hood and the diameter of the horn. It should fit close on the horn and be held in position by tape being wound very snugly around the horn just under the spreader. When the hood and spreader are in place on the horn, all excepting the lower side of the hood should have a good coat of paint.

If the lamp is suspended in front of a building the wires should run from circuit-breaker or pole to hooks in the spreader, and from there around the hood and be soldered into a wire terminal, as illustrated; the terminal should then be put over the binding post and the nut screwed down good and firm on top.

When the lamp is to be taken in for repairs, all that there is to be done is to loosen the wires and unscrew the lamp from the horn; as the lamps should be inter-changeable, another one can be put up at the time the first one is taken down. The arrangement would be similar for a lamp on a cable over the street or on a mast arm.

For inside work, since the fire underwriters will not allow wires carrying high tension current on the wood-work, we run to a knob over the lamp and from there down to terminal or binding post.

ELEMENTARY GEOMETRICAL THEORY OF THE ALTERNATE-CURRENT TRANSFORMER.—IV.

BY

Chas. Steinmetz.

III. Hysteresis and Eddy-currents.

In the foregoing, the loss of energy in the iron, due to the phenomenon of *hysteresis*, and to the existance of *eddy-currents*, was not considered. But even this can be represented easily in the polar-diagram.

The phenomenon of *hysteresis* is in reality nothing but a special application of that law of thermo-dynamics, called *Clausius' Law of Entropy*, which, briefly stated, reads, that all the transformations of energy always take place in such a manner that the sum of the latent heat-energy increases. Hence by the transformation of electric energy into magnetic energy and back again, which takes place in the transformer, a certain part of the energy is always converted into heat.

The *eddy-currents* are proportional to the magnetization; that is, for the field intensities used in transformers—which are always far from saturation—they are about proportional to the resulting M. M. F., F, and they have the same phase as the secondary E. M. F. For they are true secondary or induced currents, with only this difference, that their circuit is not closed by copper conductors, but lies entirely in the transformer-iron.

Therefore these secondary or eddy-currents also exert a certain M. M. F., A, measured by ampere-turns, and this M. M. F., A, is represented, in Fig. 5, by the circle with the line: $\overline{OA} = A$, as a diameter[1] and the phase $\vartheta = 180°$.

Now this M. M. F. *of eddy-currents*, A, combines with the *secondary* M. M. F. L_1 and the *primary* M. M. F. L to the *resulting* M. M. F., F.

Hence F, L_1 A being known, the primary M. M. F. L is found as the last side of the *polygon of sine-waves*, produced by the M. M. F.'s, F, L_1, A.

Or: The primary M. M. F. L and the secondary M. M. F. L_1 must combine by the parallelogram of sine-waves to a M. M. F. $G' = \overline{OG'}$, which, combined with $A = \overline{OA}$ gives the resulting M. M. F. F.

This M. M. F. G', I call the "*electro-magnetomotive force*" of the transformer, because it is the resultant of the two M. M. F.'s of the two *electric* circuits of the transformer.

Thus we derive: *The eddy-currents produce a retardation, that is, a lagging of the resulting* M. M. F. *F and therefore of the magnetism M of the transformer, behind the electro-*M. M. F. *G', by an angle ε.* This retardation can never equal 0, as long as iron is an electric conductor; but it ought to be very small, if the iron laminæ are really insulated from each other.

The angle of this retardation is, within certain limits, independent of the magnetization. For the eddy currents are proportional to the intensity of the magnetism, and therefore to the resulting M. M. F. F, so that $\frac{A}{F}$ is a constant, the tangent-function of the shifting of phase between electro-M. M. F. and magnetism, caused by eddy-currents, being

$$\tan \varepsilon = \frac{A}{F}.$$

But this value of $\tan \varepsilon$ is proportional to the number of periods N, used. For by increasing the number of periods N, that is, decreasing the time of one period T, we proportionally increase the E. M. F. which produces the eddies. Hence we increase the eddies and their M. M. F., proportionally to the increasing number of periods.

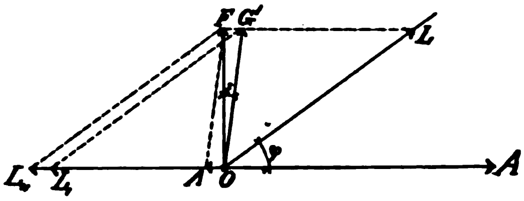


FIG. 5.

For the number of periods, $N = 133$, let the angle of shifting of phase of the resulting M. M. F. F, against the electro-M. M. F. G', be $\varepsilon = 7.5°$ (actual test).

That is, in our transformer, the M. M. F. of the eddies:

$$A = F \times \tan \varepsilon = 320 \text{ ampere turns.}$$

Hence, after having determined angle ε, we draw, in Fig. 6, FL_1, and find the electro-M. M. F. G' by erecting a perpendicular line in F upon $\overline{OF}$, and producing angle $G'OF = \varepsilon$. Then $\overline{OG'}$ is the electro-M. M. F., and connecting G' with L_1 and completing the parallelogram, $OL_1G'L$, we get the primary M. M. F. L, and therefrom, in the same way as in Figs. 2 and 3, the primary current, C, the primary E. M. F. E_0, etc.

Or, we produce, in Fig. 5, line $\overline{OA} = 320$ ampere turns $= .096$ inch as the M. M. F. of the eddy-currents, with the same phase as the secondary E. M. F. E_1. Then the resulting E. M. F., $\overline{OF}$, is the diagonal of the parallelogram, which has $\overline{OA}$ as one, and the electro-M. M. F., $\overline{OG'}$ as the other side. Hence we get $\overline{OG'}$ by producing this parallelogram, $OAFG'$, and from $\overline{OG'}$ and $\overline{OL_1}$ we derive $\overline{OL}$, etc.

Or, in Fig. 5, we combine directly both secondary M. M. F.'s, $\overline{OL_1}$ and $\overline{OA}$, with the M. M. F., $\overline{OL_{11}} = \overline{OL_1} + \overline{OA}$, and from these combined M. M. F.'s and the resulting M. M. F. $\overline{OF}$, we get $\overline{OL}$ by means of the parallelogram: $OL_{11}FL_1$, and from this the other quantities.

When a more exact determination of the eddies is needed, especially for transformers with variable magnetism (constant-current transformer), their dependence upon the varying magnetic conductivity has to be taken into account, as will be shown later on.

Much more complicated is the phenomenon of *Hysteresis*, because it changes perceptibly the shape of the primary current wave, at least for open secondary circuit, making its increase slower, and its decline steeper.

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[1] In the following, we leave out the circles, which give the instantaneous values of the different quantities, and represent them by their diameters only, as their maximum values.

But, at least as far as my experience goes, even this influence of hysteresis can be accounted for by a simple shifting of the phase of resulting M. M. F., or magnetism, against the phase of impressed M. M. F. by an angle, χ.

By means of this angle χ, or the *ideal* M. M. F. *of hysteresis*, $\overline{O\Gamma_1}$, we derive the *impressed* M. M. F., $\overline{OG}$, and from this the secondary M. M. F., L_1, in the usual way in Fig. 7, the primary M. M. F., $\overline{OL}$.

Only, this angle χ of *hysteretic lag is not* independent of the magnetization, but *decreases* with increasing magnetization; and it seems that the *sine-function* of the angle of hysteretic lag is about proportional to the —.4th power of the intensity of magnetic field:

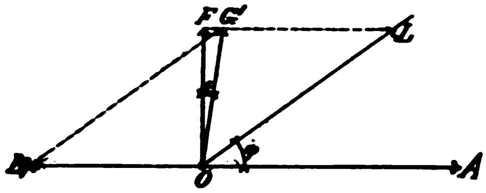

FIG. 6.

$$\sin \chi = a\, B^{-.4}.$$

This angle χ is *independent* of the number of periods, N. For the loss of energy due to hysteresis is *directly proportional* to the number of periods, N, while the loss of energy due to eddy-currents is *proportional to the square* of the number of periods N.

Hysteresis and eddies acting as they do in designing transformers, where we do not yet know exactly how far we succeed in avoiding eddy-currents, we can combine their consideration, and say:

"*Hysteresis in a transformer causes a shifting of the phase of the* RESULTING M. M. F. *and thus of the* MAGNETISM, *against the phase of the* IMPRESSED M. M. F., *that is, the resultant of the primary and the secondary* M. M. F., *by an angle* χ, *which is independent of the number of periods, and only depends upon the kind of iron used, and upon the magnetization. This angle* DECREASES *with* INCREASING *magnetization, and its sine-function is inversely proportional to about the .4th power of the magnetization.*"

"*Eddy-currents cause a shifting of phase of the magnetism against the impressed* M. M. F. *also, by an angle* ε, *which is—below th; saturation limit—almost independent of the magnetization, but depends upon the number of periods so that tan* ε *is proportional thereto.*"

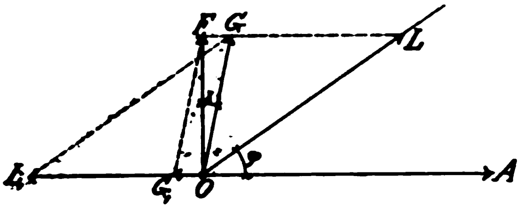

FIG. 7.

In reality this angle ε depends upon the magnetization because of the varying magnetic conductivity of the iron, and decreases for lower and for higher magnetization, reaching a maximum for medium magnetization, at that point where the susceptibility of the iron is greatest. Curves showing the dependence of this angle ε, and the angle χ, upon the magnetization will be shown later on.

"*This angle* ε *of magnetic lag caused by eddy-currents combines with the angle* χ *of hysteretic lag to form an angle,* $\eta = \varepsilon + \chi$, *which, for the usual number of periods, and, if proper care is taken for good insulation of the iron laminæ, can approximately be assumed such that its tangent-function is proportional to the —.3th power of the intensity of magnetization:*

$$\tan \eta = b \times B^{-.3}$$

Let us assume in the transformer treated as an example, that *the angle of true hystertic lag* $\chi = 11.5°$.
" " " *eddy-current lag* $\varepsilon = 7.5°$.
hence " *whole magnetic lag* $\eta = 19°$ (actual test)[2]

That is, the resulting M. M. F., and therefore the magnetism, lags behind the impressed M. M. F., or the combined M. M. F. of primary and secondary current, by an angle of 24°.

In this manner, taking into consideration hysteresis and eddies, we get, in Fig. 8, the complete diagram of our transformers:

Resulting M. M. F. F=2,400 ampere turns. $\overline{OF}$=.72 inch.

M. M. F. *of eddies*: Λ=320 ampere turns. $\overline{O\Lambda}$=.096 inch.

Ideal M. M. F. *of hysteresis*: Γ = 506 ampere turns. $\overline{O\Gamma}$=.152 inch.

Hence, *impressed* M. M. F.: K = 2,538 ampere turns. $\overline{OK}$ = .761 inch; or 138 ampere turns larger than the resulting, or magnetizing, M. M. F. F = 2,400 ampere turns.

These 138 ampere turns I called, when I first drew attention to them, somewhat over a year back,[3] the "*dead turns*," for they are lost for producing magnetism.

Or, if we apply the term "*plant efficiency*," introduced by Kapp for the ratio of the useful E. M. F. to the impressed E. M. F., to the *magnetic* circuit, the "plant efficiency" of this transformer circuit would be,

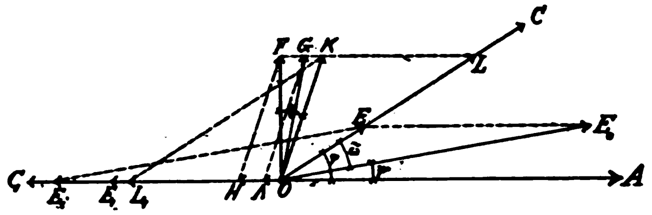

FIG. 8.

$$\frac{F}{K}=\frac{2{,}400}{2{,}538}=.945, \text{ or, } 94.5\%.$$

From the *secondary current*: C_1 = 50 amperes. $\overline{OC_1}$= 1.5 inch. And the *secondary* M. M. F., L_1 = 3,000 ampere turns. $\overline{OL_1}$ =.9 inch.

We get, by means of the parallelogram $\mathrm{O}\,\underline{L_1 K}\,L$, the *primary* M. M. F., L = 4,516 ampere turns. $\overline{OL}$ = 1.355 inch. Hence, the *primary current* C = 56.6 amperes. $\overline{OC}$ = 1.7 inch. Hence, the *resulting, or heating primary* E. M. F. E = 56.6 volts. $\overline{OE}$ =.566 inch.

Now, the *secondary* E. M. F. being, E_1 = 100 volts, $\overline{OE_1}$ = 1.00 inch. This gives the *induced primary* E. M. F., E_1' = 133 volts. $\overline{OE_1'}$ = 1.33 inch, and from this by the parallelogram, $\mathrm{O}\,E_1'\,E\,E_0$, the *impressed primary* E. M. F., E_0 = 183.1 volts. $\overline{OE_0}$ = 1.83 inch.

The *phase of primary current*, angle φ = 32.1°.

The *phase of impressed primary* E. M. F., angle ψ = 9.4°.

The *difference of phase between primary current and impressed* E. M. F., angle $\omega = \varphi - \psi$ = 22.7°.

Further considerations of the highly interesting phenomena of hysteresis I must postpone to a later occasion.

THE BABCOCK & WILCOX BOILER CO. are placing a new 500 h. p. boiler in the power station of the Rochester Railway Co., Rochester, N. Y.

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[2] Found in a laminated electromagnet, where the loss of energy in the iron was proportional to $B^{1.7}$, given on page 628, June 3.

[3] *Elektrotechnische Zeitschrift*: "Das Transformatorenproblem in elementar-geometrischer Darstellungsweise."

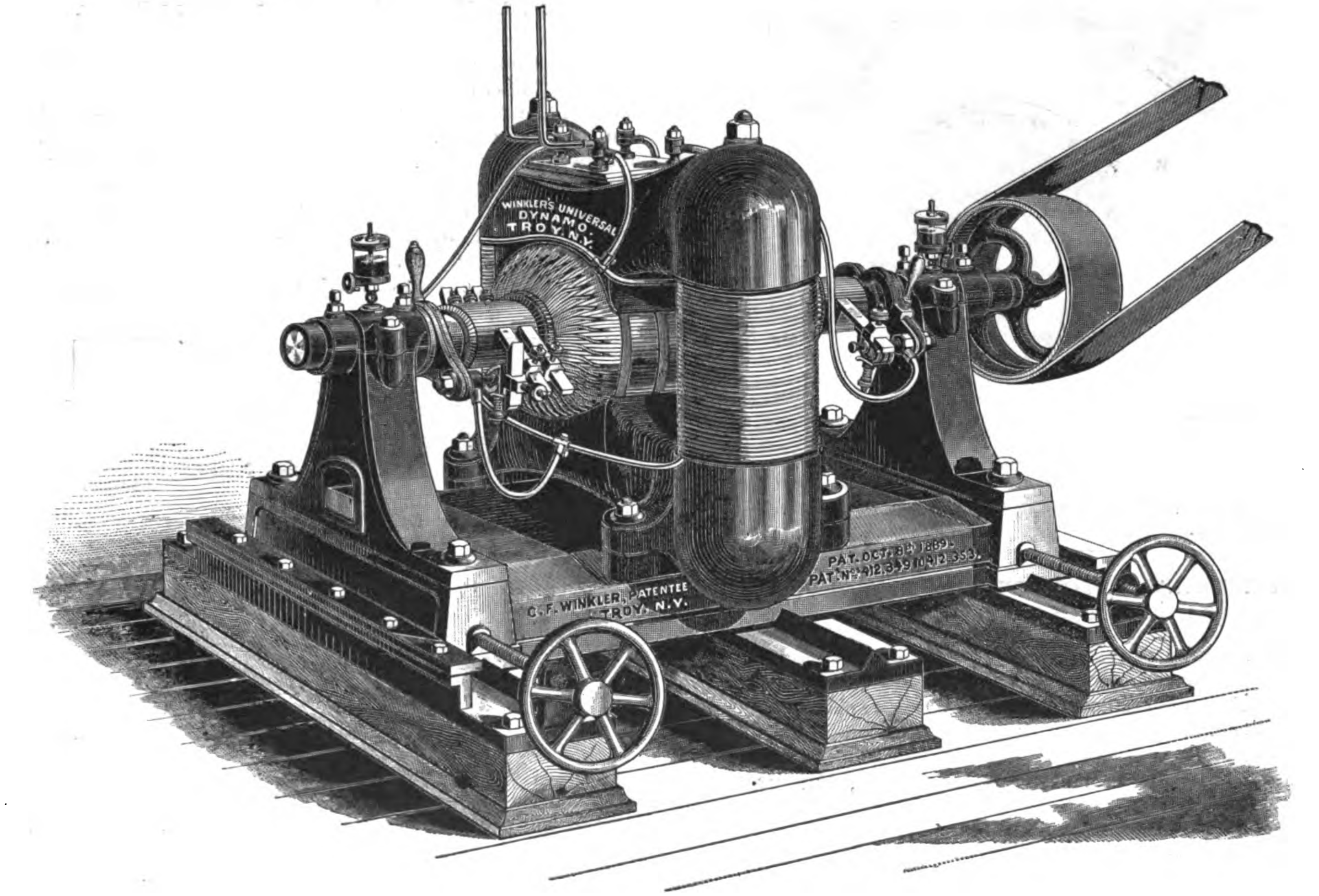
THE WINKLER "UNIVERSAL" DYNAMO.

It is now well recognized that the success of a dynamo in commercial practice depends as much upon its efficiency as a converter of energy as upon the smoothness with which it operates, or, in other words, absence of repairs. In seeking to devise a machine which shall embody all these qualities, Mr. Charles F. Winkler, electrician of the Troy Dynamo Company, of Troy, N. Y., has designed a dynamo which is illustrated in the accompanying engraving, Fig. 1, and which possesses several novel features.

Recognizing the fact that most of the trouble of dynamo machines is experienced at the commutator, Mr. Winkler has designed his machine primarily to make it absolutely non-sparking, and in the second place to make the operation of the machine independent of the load on the outside circuit. For this purpose he has adopted a construction in which the armature is wound with two independent windings, one of which is employed to generate the current taken by the field-magnets and the other to generate current for the external circuit, including the lamps or other devices.

The construction adopted for this purpose in the armature is well illustrated by the accompanying engravings, Figs. 2 and 3, which show respectively a cross-section and a longitudinal view of the armature. As stated above, the field magnets derive their current from a separate winding on the armature. This winding, in order to decrease the air gap as much as possible, consists of straight iron bars c′ c′, the inner ones c being trough-shaped, corresponding to the outlines between the end discs of the armature. The ends of the trough-shaped parts are connected to the adjoining straight bars, the arrangement being the exact equivalent of a Gramme ring winding. The ends where the bars join are connected to a commutator in the usual way. The empty space within the trough-shaped bars is filled up with soft iron wire as shown in Fig. 2, but insulated from the Gramme ring winding. Outside of this winding is placed the winding intended to feed the external circuit, including the lamps. The machine has, of course, two commutators. In the machine illustrated, which is of 400 light capacity, the Gramme ring intended for the exciting armature consists of 40 bars. These are connected to a 40-part commutator and generate 10 amperes at 34 volts with a speed of 850 revolutions. The Siemens winding employed to feed the external circuit consists of 40 coils of No. 3 B. & S. wire, of 2 turns each.

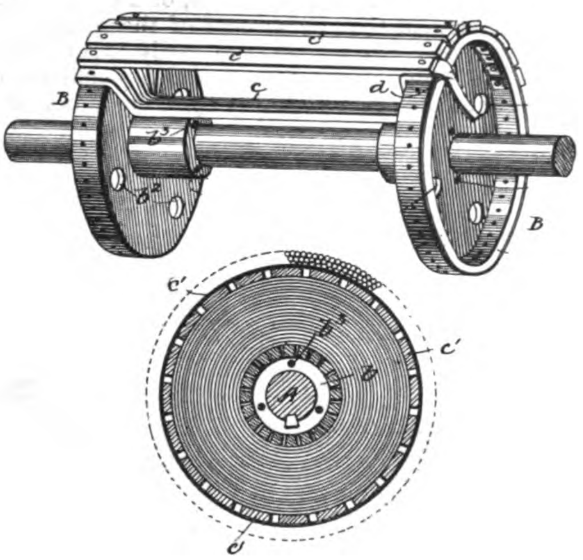
It will be evident that, on account of the separate excitation of the field, the reaction ordinarily experienced between the field and armature and which manifests itself prominently at the commutator by sparking is here absent. As a result, the most violent changes of current in the outside circuit can be effected without showing a spark in the commutator. As the armature alone, with its low self-induction, is in the main circuit, the latter can be ruptured with both terminals in the hands without giving rise to a sensible shock.


WINKLER'S UNIVERSAL DYNAMO TROY, N.Y.
C. F. WINKLER, PATENTEE TROY, N.Y.
PAT. OCT. 8th 1889.
PAT. Nos 412,349 TO 412,353.

The Winkler "Uninersal" Dynamo.

But there is still another advantage gained in this construction, which is due to the fact that it allows of the operation and regulation of the dynamo without a rheostat. By merely shifting the brushes of the exciting current commutator the potential can be varied within wide limits and maintained constant at any point. This allows of a delicate and convenient method of bringing the machine to its correct potential, and overcomes the difficulty of change of potential frequently caused by the heating of wires in the rheostat. It will be evident that the system is also applicable to the construction of arc machines, the regulation of which can be accomplished entirely by the shifting of the brushes, making contact with the exciting current commutator, which, of course, is at very low potential, and which would allow of the main high tension brushes remaining fixed in position. For fluctuating powers, also, this system of regulation, whether for constant potential or constant current, seems well adapted.

The machine above illustrated has been in operation for some time past at the works of Messrs. Miller, Hall & Hartwell, of Troy, N. Y., where it has given most satisfactory service, with practically no attention beyond the necessary lubrication at the bearings. Mr. Winkler has also designed various other sizes of these machines, the manufacture of which will probably be undertaken in the near future.



ARMATURE OF WINKLER'S "UNIVERSAL" DYNAMO.

KERSTEIN'S AUTOMATIC SAFETY DEVICE FOR OVERHEAD CIRCUITS.

THE accidents which are liable to occur and the damage which may be done by the dropping of wires carrying high tension currents upon other wires, such as telegraph, telephone, and light, and *vice versa*, make it desirable to employ some simple device to prevent them. In seeking to overcome the difficulty just mentioned, Mr. Max Kerstein, of the Electric Wire Safety Attachment Co., of Boston, Mass., has recently designed an ingenious circuit-breaker, which acts so that any disturbance in the normal condition of the line at once cuts it out of the circuit and thus renders it harmless. The operation of the attachment will be readily understood by a glance at the accompanying engravings. As shown in Fig. 1, the apparatus consists of two insulating pieces, I I, which are connected by two insulated wires, W W, one end of which is connected to a copper end piece, B, and the other joined to form one terminal of the instrument L¹. Between the insulated wires W W is placed a helical spring, which acts upon a wire carrying a plug, P, which fits into a hole in the copper end-piece B, this wire being connected forming the other terminal of the instrument L, which is connected to the other end of the line. The operation of the instrument will be now readily understood. When the line is in normal condition and taut, the helical spring is under compression, as shown in Fig. 1, the plug P making good contact with the copper end-piece B, the insulated wires W, and out to line at L¹. If the line should slacken but very slightly, or break, the helical spring will be relieved and push the plug out of contact with the end-piece B, as shown in Fig. 2. The circuit will thus be immediaiely broken and the wire beyond the break be rendered perfectly harmless both to property and life. The apparatus, which can be very cheaply constructed, is enclosed in a cover, as shown in Fig. 3, and in practice it is designed to have one attached at each pole so that a break between any pole on a circuit will be followed by immediate rupture of the circuit. It is evident that the device is applicable to electric lighting, and to railway circuits as well; and on the other hand, its attachment to telegraph and telephone circuits will go far towards ending the many complaints which have arisen on account of the dropping of these wires upon the bare electric railway circuits.

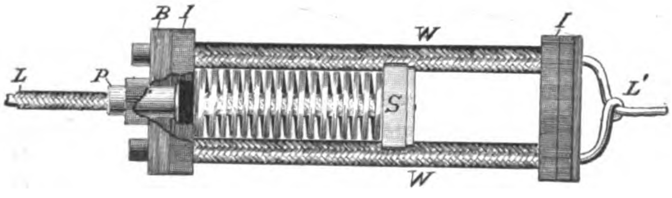


FIG. 1.—KRESTEIN'S AUTOMATIC SAFETY DEVICE.

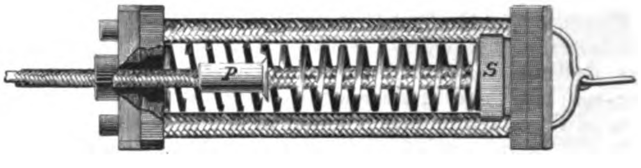


FIG. 2.—KERSTEIN'S AUTOMATIC SAFETY DEVICE.

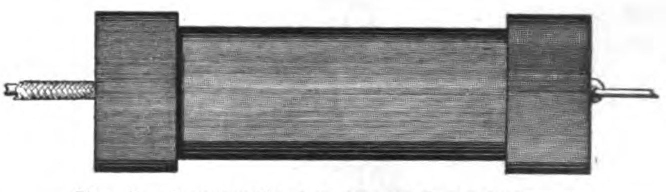


FIG. 3.—KERSTEIN'S AUTOMATIC SAFETY DEVICE.

THE ELECTROLYTIC ASSAY OF COPPER.

IN assaying copper by the electrolytic process it has been observed that sometimes the copper deposited at the beginning of the process is of a dark brown color, and whenever this is the case it usually happens that the remainder of the metal comes down in a "fluffy" condition. There is a short letter on this subject in the *Chemical News* for May 29th, in which the writer who has himself frequently experienced the same trouble states that the cause of it may be traced to using a current that is too strong for the solution. With a weaker current of electricity, and also possibly with a weaker solution of the copper, the metal would be deposited upon the cathode in a firm crust which would possess the usual shiny or rosy appearance. Whether the darkening spoken of above that is sometimes observed at the commencement of the electrolysis is due to the presence of some trace of foreign impurity set free by the current being too strong, or whether the color is due to the molecular state or physical aggregation of the deposited metal, does not transpire.

MR. CHAS. HIGGINS has been appointed Superintendent of Fire Alarm and Police Telegraph, St. Louis. Mr. Higgins has long been connected with the Western Union Telegraph Company, and for a number of years previous to this appointment was Manager of the Merchant's Exchange Office.

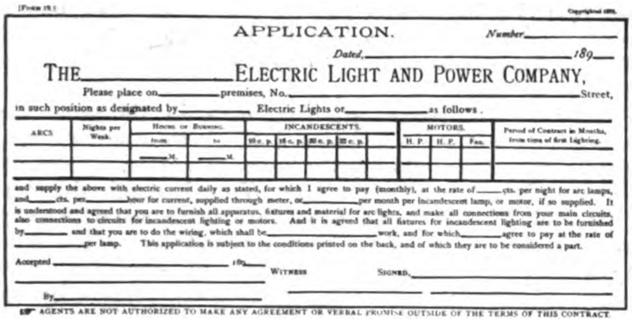
CENTRAL STATION MANAGEMENT AND FINANCE.—VIII.

BY

Horatio A. Foster

Department of Accounts.

In this department the first item is the contract, or, as the writer prefers to call it, the "application," which is, of course, preliminary to all business. Blank No. 19 will be found convenient as furnishing all necessary data and conditions. The usual form of contract is a large document of legal appearance, and is apt to frighten prospective customers off. By presenting this small slip, headed "application," *not* contract, it is found to be much easier to secure its signature. When the application has been accepted by the company an installation order should be issued to the superintendent or other proper authority using the regular Order Blank No. 1. In this connection it is convenient to have a couple of rubber stamps, one for arc and one for incandescents, which will stamp all form of data on the face of the order blank. No. 1 stamp reads as follows :—



[Form 19.] Copyrighted 1891.

APPLICATION. *Number*______

*Dated,*______ *189*__

THE______ELECTRIC LIGHT AND POWER COMPANY,

Please place on______premises, No.______Street,

in such position as designated by______ Electric Lights or______as follows .

ARCS.	Nights per Week.	Hours of Burning.		INCANDESCENTS.					MOTORS.			Period of Contract in Months, from time of first Lighting.
		from	to	10 c. p.	16 c. p.	20 c. p.	32 c. p.		H. P.	H. P.	Fan.	
		____M.	____M.									

and supply the above with electric current daily as stated, for which I agree to pay (monthly), at the rate of____cts. per night for arc lamps, and____cts. per______hour for current, supplied through meter, or______per month per incandescent lamp, or motor, if so supplied. It is understood and agreed that you are to furnish all apparatus, fixtures and material for arc lights, and make all connections from your main circuits, also connections to circuits for incandescent lighting or motors. And it is agreed that all fixtures for incandescent lighting are to be furnished by______ and that you are to do the wiring, which shall be______work, and for which______agree to pay at the rate of______per lamp. This application is subject to the conditions printed on the back, and of which they are to be considered a part.

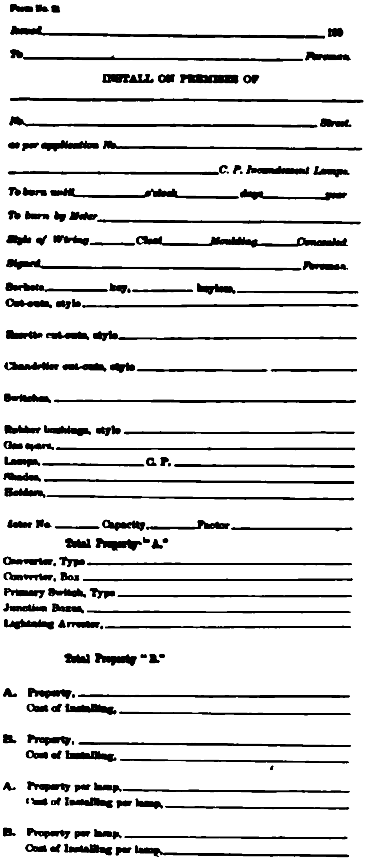
Accepted______189__

WITNESS______ SIGNED,______

By______

☞ AGENTS ARE NOT AUTHORIZED TO MAKE ANY AGREEMENT OR VERBAL PROMISE OUTSIDE OF THE TERMS OF THIS CONTRACT.

Form No. 19.—Application Blank.



Form No. 21

*Issued*______189

*To*______*Foreman.*

INSTALL ON PREMISES OF

______

*No.*______*Street.*

*as per application No.*______

______*C. P. Incandescent Lamps.*

*To burn until*______*o'clock*______*days*______*year*

*To burn by Meter*______

*Style of Wiring*______*Cleat*______*Moulding*______*Concealed*

*Signed*______*Foreman.*

Sockets,______key,______keyless,______

Cut-outs, style______

Rosette cut-outs, style______

Chandelier cut-outs, style______

Switches,______

Rubber bushings, style______

Gas spurs,______

Lamps,______C. P.______

Shades,______

Holders,______

Meter No.______Capacity,______Factor______

Total Property "A."

Converter, Type______

Converter, Box______

Primary Switch, Type______

Junction Boxes,______

Lightning Arrester,______

Total Property "B."

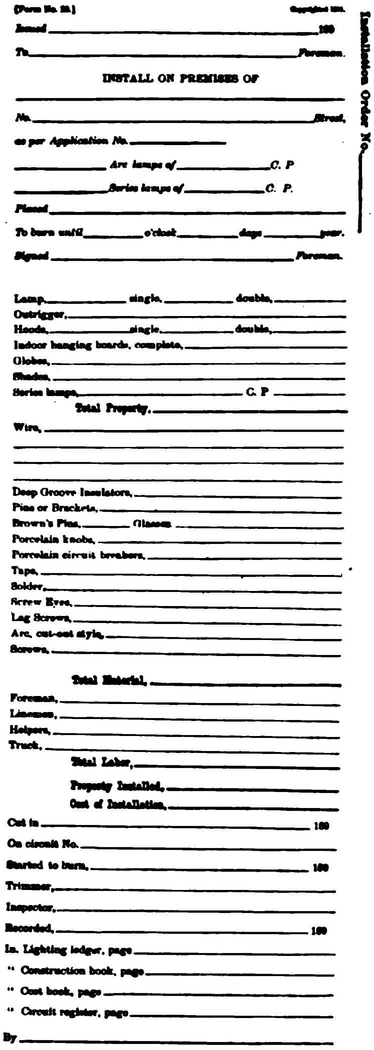
A. Property,______
Cost of Installing,______

B. Property,______
Cost of Installing,______

A. Property per lamp,______
Cost of Installing per lamp,______

B. Property per lamp,______
Cost of Installing per lamp,______

Form No. 21.—Special Order Blank For Installation Work.



[Form No. 20.] Copyrighted 1891.

*Issued*______189

*To*______*Foreman.*

INSTALL ON PREMISES OF

______

*No.*______*Street,*

*as per Application No.*______

______*Arc lamps of*______*C. P*

______*Series lamps of*______*C. P.*

*Placed*______

*To burn until*______*o'clock*______*days*______*year.*

*Signed*______*Foreman.*

Installation Order No.______

Lamp,______single,______double,______

Outrigger,______

Hoods,______single,______double,______

Indoor hanging boards, complete,______

Globes,______

Shades,______

Series lamps,______C. P______

Total Property,______

Wire,______

Deep Groove Insulators,______

Pins or Brackets,______

Brown's Pins,______Glasses______

Porcelain knobs,______

Porcelain circuit breakers,______

Tape,______

Solder,______

Screw Eyes,______

Lag Screws,______

Arc, cut-out style,______

Screws,______

Total Material,______

Foreman,______

Linemen,______

Helpers,______

Truck,______

Total Labor,______

Property Installed,______

Cost of Installation,______

Cut in______189

On circuit No.______

Started to burn,______189

Trimmer,______

Inspector,______

Recorded,______189

In. Lighting ledger, page______

" Construction book, page______

" Cost book, page______

" Circuit register, page______

By______

Form No. 20.—Special Order Blank For Installation Work.

DIAGRAM No. 1.

INSTALL ON PREMISES OF

....

No.... ....Street,

..........................arc lamps,

as per contract number...................................

To burn until.......o'clock.......days, for......months.

Trimmer ....

Inspector..

Recorded........................... 189

In circuit register, page..................................

Lighting register, page...................................

By............. ....

These rubber stamp diagrams, Nos. 1 and 2, are made of such size as to fit on to face of order blank No. 1.

And the No. 2 stamp, as below.

DIAGRAM No. 2.

INSTALL ON PREMISES OF

....

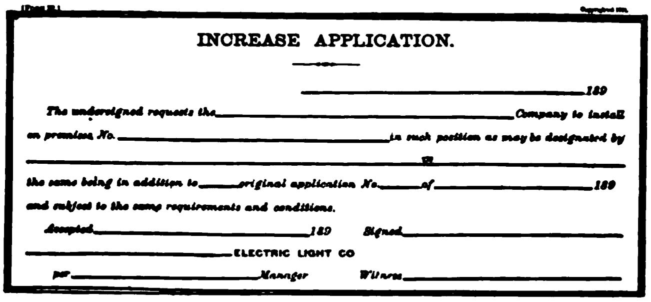
No...................... .. ..Street,

as per contract number....................................,

..............................c. p. incandescent lamps,
....
To burn until.......o'clock.......days, for......months,
on Meter or Contract.
Inspector.... ....
Recorded...189
In circuit register, page...............................
Lighting register, page.................................
By...

This order, when properly returned with stock and labor list on the back, gives a complete record of the cost of that particular installation, which can be copied into the proper account books, as indicated by portions of the diagrams.

Some larger stations will prefer a special order blank for installation work, and in many cases it is very convenient, as employees often forget items unless they are printed for them in plain sight. Blanks Nos. 20 and 21 have been used largely by the writer for this purpose and are found to be entirely satisfactory. With the Application Blank No. 19, there must also be included another blank, No. 22. which is used for any future increase of the first application, and, being of a different color and filed with the original, it is easily distinguished.



INCREASE APPLICATION.

________________189

*The undersigned requests the*________________*Company to install*
*on premises No.*________________*in such position as may be designated by*
____
*the same being in addition to*______*original application No.*______*of*________________*189*
and subject to the same requirements and conditions.
*Accepted*________________*189* *Signed*________________
________________ELECTRIC LIGHT CO
*per*________________*Manager* *Witness*________________

FORM NO. 22.—BLANK FOR INCREASE APPLICATION.

THE CLARK STANDARD CELL.

BY

Elmer G. Willyoung

DURING the past few weeks attention has again been drawn to the subject of standard cells both in the columns of THE ELECTRICAL ENGINEER and elsewhere. The necessity of a standard thoroughly reliable and convenient in use is becoming more and more evident every day. Editorial remarks in the issue of June 3d of THE ELECTRICAL ENGINEER lament the fact that there is still to be made a standard simple in construction and hence available to all. While, of course, greater simplicity is a desideratum in all things, yet we must acknowledge, I think, that there are limits beyond which further simplicity could hardly be expected. I think, too, that THE ENGINEER has hardly used the correct word when it speaks of *simplicity* in the construction of standards. When we consider the form and the methods of attaining standards other than electrical, we see that what is required principally is knowledge how, and practical skill, to construct the standards. The standard yard is *simple* enough, being merely a copy of a certain original which has been securely kept, and yet the exact reproduction of this original standard is a matter which cannot be successfully accomplished by any less a person than one who has given a great deal of attention to this particular order of work as, for instance, Prof. Rogers or Prof. Rowland. The making of the standards of length and capacity sent out by the U. S. bureau of weights and measures, at Washington is, in one sense of the word, a simple matter, all that is required being suitable instruments and *care;* principally the latter.

What has been said of the mechanical standards is equally true of all electrical standards. The making of commercial and laboratory standards of resistance means merely an exact measurement; there is nothing complicated about this operation; the methods suitable for doing it are easy of comprehension; the *one* thing which is required is *care*, and the *greatest* care. The construction of a standard condenser, or of a proper standard of self induction, are *simple* matters and explained quite fully in most text books on electric technics; what cannot be gained, however, except by practical experience is the skill to follow these directions or, to better express the idea, the ability to be careful enough.

If now we will regard standard cells in the same way that we regard other standards, I think we shall see that their construction could hardly be more simple. Take, for instance, a standard Daniell cell. What is required? Pure $CuSO_4$ and $ZnSO_4$ made into solutions of equal density, pure zinc and pure copper, cleanliness and care. The same is true of the various forms of Clark cell—pure materials, cleaniness and care. To expect reliable results by the violation of any of these three conditions would be to expect a violation of the laws of chemical and electrical action.

The greatest bane of a business man is the man who wants something for nothing, and no well-thinking individual can have any real sympathy for such a one. A good standard cell can be had by every one by paying for it either in their own time to make it themselves, or in money, the equivalent of their time, to those who are skilled in the construction of such cells.

To speak more particularly of standard cells. A good many forms have been suggested, as for instance the mercury oxide cell of M. Guoy, the various forms of Daniell, the normal Latimer Clark, as investigated by Lord Rayleigh, and last the modification of the normal Clark, studied by Prof. Carhart. The mercury oxide cell is undesirable on account of its low E. M. F.; it is also not as permanent as the other cells mentioned. The Daniell cell is, undoubtedly, easier to make than the Clark. Slight variations in the ingredients in the former do not affect the E. M. F. as much as similar variations in the latter. Still we must be careful. Our zinc must be pure and unoxidized, our solutions must be of uniform density, and, what is more troublesome than anything else, our copper must be freshly electroplated and free from oxide. Were we to use a standard cell but once in a lifetime or even once in six weeks, all this would be easy to do, but where a cell is to be used every day, or three, or four, or even more, times a day, the care of the cell becomes very laborious. A Daniell cell is *never* ready when you want to use it. Something has always to be done. The copper has to be freshly electroplated, solutions have to be drawn off so as to give the sharp line of demarcation necessary, etc. But worst of all with the Daniell cell is the fact that the cell must practically be *constantly* watched in order to avoid resetting the cell in its entirety every time it is used. If it is not watched and inspected carefully every day, the zinc and copper sulphate solutions will diffuse, and the moment the slightest trace of the copper salt reaches the zinc plate, then farewell to our standard. The E. M. F. immediately drops 2, 3, or 4 per cent. below its normal value, and the cell is useless.

But how is it with the Clark cell? More tedious to make than the Daniell, unquestionably; greater care by far is necessary in using only perfectly pure materials and in preserving them uncontaminated until the cell is filled and sealed. And yet, after all, it is only care that is necessary. By consulting an old note book I find that the first two cells I ever made (according to Lord Rayleigh's directions) when an inexperienced University student agreed in value with one another within eight parts in ten thousand, or less than $\frac{1}{10}$ per cent. This shows that Clark cells *can* be made if one cares to take the pains and the time. The fact, however, that no chemicals, as ordinarily sold by dealers are pure enough for Clark cells, together with the great care necessary in their manufacture, makes it much more desirable and economical for the average busy electrician to purchase his standard of those used to making them, rather than to make his own.

The Clark cell, if well made, is *always* ready for use and *always* reliable; *it does not change its value in time.* To prove this I need but refer to Prof. Carhart's article in the issue of June 3d of The Electrical Engineer, where is printed a comparison of four cells with one another, two of the cells having been made four years before the other two. Further, one of these older cells had been used indiscriminately by all electrical students frequenting the laboratory during these four years without any regard whatever to electrical proprieties; nevertheless, as is seen, these cells agree with one another within $\frac{2}{100}$ per cent. and the old ones with the new ones within the same percentage.

Thus we see that the Clark cell possesses two of the principal requirements of a good standard. Another qualification possessed by it, and by no means common to all standards, is durability or, to use other phraseology, lack of excessive delicacy. To use it and secure thoroughly reliable results only a few simple precautions need be observed. It should always be used with a resistance in circuit, and the circuit of the cell kept closed no longer than strictly necessary. Should, however, the circuit be closed on so low a resistance as 10,000 ohms for as long as two or three minutes no particular harm will result. The polarization thus produced will not affect the E. M. F. by more than about $\frac{1}{10}$ per cent., and the cell rapidly recovers this small amount when left on an open circuit. The Clark cell also may be very conveniently carried about the laboratory. This is not the case with the Daniell, which needs to be handled with great care to prevent diffusion of the solutions or spilling. Being small and capable of being very conveniently mounted, the Clark cell is a much handier thing to use than any other form of standard known.

It has always been supposed that the Clark cell was a very frail thing to handle and that, at best, it could not be depended upon for longer than a very brief period. Many people have unpleasant recollections of Clark cells imported from abroad, and found nowhere near standard when they reached this side, if indeed they appeared to possess any E. M. F. whatever. I have a letter from one of the most prominent electrical authorities in this country before me as I write, dated about one year ago, in which he says, "No Clark cell can be made which will stand transportation." Nevertheless such a cell has been made and is being transported with perfect success continually. Tests made upon cells of Prof. Carhart's form, which have been shipped from Ann Arbor to Philadelphia and back again, show results agreeing with one another within $\frac{3}{100}$ or $\frac{4}{100}$ of one per cent. A short time ago in order to see how much jarring and shaking a cell would stand I took one up and shook it vigorously, just as one would shake a bottle of medicine, to thoroughly mix the contents; after eight or ten seconds' shaking of this kind I allowed the cell to rest about five minutes and then repeated the shaking. A measurement was then taken with the result below:

Before 1st shaking: Resistance to balance . . 9,134 ohms
After 2d " " " " . . 9,129 "

or a difference of about $\frac{4}{100}$ per cent. This shaking was so vigorous that considerable of the mercury got broken up and mixed in with the salt.

In the orthodox Clark cell a good deal of trouble has been experienced in the sealing, which would often crack away from the sides of the tube in which the cell was mounted, thus allowing the solutions to evaporate. By the use of a special compound, having nearly the same coefficient of expansion as glass, the seal as made in Prof. Carhart's cell is much more effective than in the usual form. Should, however, slight leaks develop, it has been found that the E. M. F. is not appreciably changed thereby.

That the Clark cell has proved its superiority over the Daniell is shown by the fact that the Electrical Standards Committee of the English Board of Trade are considering its use as the official standard, and they have drawn up a provisional memorandum of instructions for making these cells.

In conclusion, it may be said that the Clark cell as a standard of E. M. F. is probably as easy to make, if not more so, than any other standard known of any kind; and in the hands of a man having need of standards, and hence capable of using them, will probably give less trouble than any other standard or standard instrument. Always ready for use, an important measurement can be completed with it before a Daniell could be given half the necessary inspection. No laboratory is complete without a Clark cell.

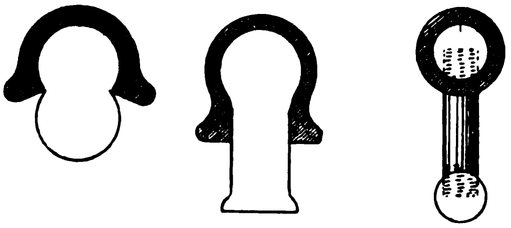
A COMBINED FEEDER AND TROLLEY WIRE.

BY

Birdsall.

The recent published account of an insulated trolley wire called to mind some sketches of a combined feeder and trolley wire made by the writer nearly a year ago.

In the accompanying sketches, which are copied from my note and sketch book, the shaded portions represent the insulation, the unshaded portions copper.



Figs. 1, 2 and 3.—Birdsall's Combined Feeder and Trolley Wire.

The writer has long advocated the use of a trolley wire the shape of Fig. 1, as by this form all flashing due to the trolley wheel striking the clips would be eliminated.

Having arrived at a wire of this section, it naturally follows that the upper half could be insulated, thus serving as a guard wire.

AN EFFECT OF HIGH PERIPHERAL VELOCITY.

A Montreal correspondent of *Nature* communicates the following result of an experiment regarding the whirling of steel bands, about which there has recently been some controversy in that journal:—A weldless steel flash, with spherical body 12 in. in diameter and $\frac{3}{8}$ in. thick, constructed for use in a centrifugal milk separator, to revolve about its axis of symmetry at a normal speed of 7,000 revolutions per minute, was whirled at a gradually increasing speed, with a view to ascertaining the "bursting" velocity. At 16,000 revolutions per minute the body of the flash had bulged 2 in. in diameter. This is equivalent to an extension of 17 per cent., the peripheral speed being 840 ft. per second (about 570 miles an hour), and the tension 31·5 tons per square inch.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. XI. NEW YORK, JUNE 24, 1891. NO. 164.

The very discovery of law is regulated by law.—Josiah Parsons Cooke.

THE ART OF INSULATION.

IN keeping with the advances which have been made in other departments of electricity in its practical applications, changes are gradually taking place in the current ideas regarding insulation, and new methods are being applied in conformity therewith. The limited supply of gutta-percha and rubber has for some time past made it apparent that unless new sources of supply open up, insulating materials other than those mentioned must be looked for to meet the enormous demand for insulated wire of various descriptions. And again our preconceived notions of the insulating properties of air have been somewhat modified of late by demonstrations carried out with high-tension currents, which leave no doubt of the fact that air, except under very special conditions, cannot be employed as the insulating medium for very high-tension currents. Up to the present, of course, solid insulators are almost of universal application, and will probably continue to be the only practical method for a long time to come; but the resisting qualities of oil have been proved to be so remarkable that for many purposes it cannot fail to find very many applications in the future, especially in connection with high-tension transformer work, both in the station and in the distributing system.

But in addition to the development of methods for obtaining electrical resisting properties in insulators, there are distinct signs of improvements in other directions, more particularly where the capacity enters as an important factor. Thus, it is scarcely three years ago that the standard specification for telephone cables adopted by many telephone companies in this country limited the static capacity of the conductor to .18 microfarad per mile, which at that time was considered as low a capacity as could be produced commercially and still retain the other necessary properties of the conductor. But astonishing as it may seem, the recent improvements in cable manufacture have lead to the gradual lowering of the capacity until at the present time manufacturers guarantee cables to have less than one-half the capacity specified three years ago. This condition has been brought about largely by the adoption of paper as an insulation.

The facts just pointed out are but a few of the many which we think go to prove that the misgivings of those who hold that the art of insulation has been lagging behind the progress in other electrical branches are unfounded. Not, indeed, that improvements are not still wanting, but if the rate of progress manifested in the last five years is maintained, there need be no fear of lack of means of confining the current within channels both safe and suitable for the various classes of conductors.

DEATHS FROM ELECTRICITY IN NEW YORK.

THE usual yearly returns of the number of deaths in this city due to accidents, and of the nature of the accidents, have now been made public. Dr. R. S. Tracey's report for the Health Board shows that 1,333 deaths in this city during 1890 were due to accidents and negligence. To the electrical engineer, these figures, after the attack that has been made on electricity as a means of distributing light and power, would be rather amusing, but for their intrinsic sadness in showing how great is the waste of human life in our great cities. Columns upon columns fill the papers about the perils of the deadly current—even the poor innocent trolley that never took a single life is also called "deadly"—and yet when we look over these returns we find that electricity is held responsible for *just two deaths!* Neither of them was a necessary sacrifice, but may fairly be attributed in large measure to the neglect of even ordinary precautions by the victims. Only two out of 1,333. It would be extremely interesting to have the statistics of newspaper columns of gush and drivel and sensation per death; probably, those two deaths took up as much space that was not valuable as nearly the whole 1331 remaining. There are 116 deaths ascribed to suffocation. Has anybody seen an article on that subject? There are 11 due to the careless use of kerosene; 62 to sunstroke. Has anybody seen any remonstrance about the need of insulated sidewalks for summer time? There are 71 deaths attributed to railways, and 44 to street vehicles; but poor James Redpath, once a prince of New York journalists, run over in the street, could go down to his death with hardly a protest from his old colleagues and without any suggestion that all the cars should stop running until every inch of track had been put in order. No fewer than 36 deaths were caused by falling down elevator shafts, and 42 are written up to the account of poison, chiefly illuminating gas; but Mayor Grant has not indulged in heroics about elevators, nor has he been heard to say that it was a peculiar part of his duty to keep the citizens from dying from the inhalation of illuminating gas.

That there are only two deaths due to electricity is something which the Board of Electrical Control may reasonably take pride in, for the freedom from accident is the result of good rules intelligently lived up to by the local companies. Dr. Wheeler has had an ordeal as expert of the Board that few men would care to go through, but these figures stand to his credit as evidence of care and ability that nothing can gainsay. Accidents will happen with any of the great forces that modern civilization uses, but it is a public duty to keep the number down to the minimum. We make bold to say that the returns of 1890 show an electrical minimum which we can all point to as an overwhelming proof of the safety of electricity, for never was there so much high tension current used in this city before.

THE LIGHTNING ROD QUESTION.

In our last issue we drew attention in these columns to the fact that some diversity of opinion still existed as to the true functions of the lightning rod, and hence it is not a matter of surprise that the mind of the layman should be clouded with uncertainty. The paper read before the American Institute of Electrical Engineers by Mr. N. D. C. Hodges has served again to call attention to this subject, and in response to queries from the New York *Tribune* concerning the necessity for lightning protection, the nature of electrical discharge, and the manner in which the rod should be erected, Prof. Elihu Thomson has given his opinion, which is evidently the outcome of much thought.

Prof. Thomson thinks there can be no question that a properly constructed and arranged lightning rod will afford complete protection of buildings from the effects of lightning discharges. In his opinion, a lightning rod does not have any considerable effect in conducting off discharges from the cloud silently, for the reason that the development of the conditions of the discharge from cloud to earth is frequently too sudden to allow any rod or rods to effect this work of conduction in a silent manner. He admits that on this reasoning the presence of a lightning rod may, and perhaps often does, conduce to the building being struck by lightning, but it is much better, evidently, to have the building struck a number of times without doing any harm than run the risk of having it once struck without any means of conduction, except through the poorly conducting portions of the building, which are almost sure to suffer injury or destruction. Prof. Thomson is of the opinion also that lightning rods are not of much utility in the case of buildings which have metal pipes running from the ground up to the highest story and through the roof, especially if these pipes should extend to a considerable height above the highest part of the building; and that lightning rods are but of little use for buildings adjoining tall chimneys or church spires, themselves provided with good lightning conductors. From these conditions Prof. Thomson points out that the most perfect lightning protection is obtained when the building is virtually in a metallic cage, the parts of which in connection with the earth are very thoroughly grounded, but such thoroughness as this is not necessary, as even with a large building the carrying of a conductor down each corner and grounding it would be sufficient.

As regards the size of conductors and their form, Prof. Thomson draws attention to the fact that a half inch iron rod has never been known to be injured by the passage of the lightning discharge, and he says that a one inch iron pipe with screw joints and thoroughly painted or a flat strip of copper, $\frac{1}{16}$th inch thick by 1½ inches wide, securely tacked to the building would answer all purposes. With regard to the query "What is the Nature of the Electrical Discharge?" Prof. Thomson sums it up briefly by stating that it is the conversion of the electrical energy into the energy of light and heat. According to Prof. Thomson, a discharge of a cloud to earth in a lightning flash is simply the sudden relief of electrical pressure due to a condensation or accumulation of electricity induced by the formation of rain drops. An accumulation of electricity in a clould seems to be concomitant with a sudden condensation of vapor, which takes place on the cooling or rarefaction of the vast bodies of moist air. If the air before the condensation was in any way electrified, however slightly, the condensation or conversion of the cloud into drops of water would be very apt to be followed by the existence of an electrical charge in the cloud. A thunder storm ceases when the condensing action stops. Concerning the action of a lightning rod in saving a building from harm, it is merely a provision of a path or centre of action for the discharge in the vicinity of the building, of such a character that the discharge selects it in preference to forming a centre of discharge or path for itself through the building. On account of the high potential of the lighting discharge, it is evidently without avail to insulate rods from buildings, and it matters very little whether they are insulated or not. Where there are large masses of metal in a building it is well to connect them to the ground as well as to the lightning rods.

As regards the type of dissipatible conductor and the ideas advanced in its favor by Mr. N. D. C. Hodges, Prof. Thomson believes the latter not to be grounded on correct principles. As lightning does damage only when it avoids the lightning conductor and passes through the building, Prof. Thomson argues that if it should avoid Mr. Hodges' type of dissipatible conductor, it would do equal damage. The fallacy, according to Prof. Thomson, consists in the fact that Mr. Hodges supposes the work of the discharges to be confined to that very short length between the top of the building and the ground; but, according to Prof. Thomson, the giving out of energy of a lightning discharge is by no means confined to the building which is struck or the lightning rod which carries it, but, on the contrary, this portion of the path receives but a small fraction of the total energy. Again, to provide a lightning rod which is partly or wholly destroyed during a thunder storm would invite danger from a second discharge, one against which no provision could be made. In conclusion, Prof. Thomson is of the opinion that Franklin's great invention of the lightning rod has been brought into discredit principally by the poor methods adopted in the erection of such rods and for which the lightning rod man is largely responsible. With the proper means of construction, therefore, the simple, efficient lightning rod provided by Benjamin Franklin, with the improvements in details and disposition about the building, is quite able to afford the right kind of lightning protection for buildings.

EXPERIMENTS ON THE ELECTRIC DISCHARGE IN VACUUM TUBES.

BY

Elihu Thomson

I HAVE been much interested in the account of novel phenomena given under the title "Some Experiments on the Electric Discharge in Vacuum Tubes," by Prof. J. J. Thomson, and published in your issue of June 10, inasmuch as several months ago I tried the same, or a very similar, experiment to that in which an induced discharge in a closed circuit vacuum receiver was obtained.

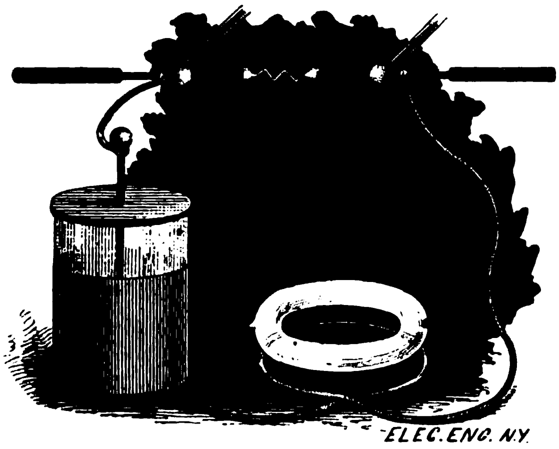

FIG. 1.—ELECTRIC DISCHARGE IN VACUUM TUBE.

Briefly, my experiment was performed with a closed ring made of a glass tube about one inch in diameter, the external diameter of the ring being about six inches. This was exhausted to a fairly good vacuum and laid alongside of a single turn of heavily insulated wire, which formed part of the discharge path from the outside of a Leyden jar, arranged to be charged and discharged rapidly by a Toepler-Holtz machine. It was found that at every discharge of the jar there was a discharge in the tube giving a band of light in the vacuous space. The accompanying engraving Fig. 1 shows the arrangement of apparatus as just described.

It will be evident that to obtain the greatest value of electromotive force in the discharge tube the inducing turns should not exceed one, as otherwise the arrangement becomes a transformer, reducing the potential in the discharge tube. The wire used for the single inducing turn should be very heavily insulated and its turns separated, or the discharge may break through and, instead of going around the turn, short-circuit it. The potential induced in a single turn under these conditions of the experiment may easily reach 10,000 volts or more.

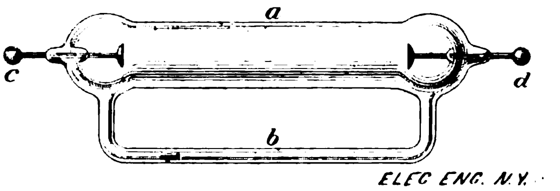

FIG. 2.—ELECTRIC DISCHARGE IN BRANCHED VACUUM TUBE.

Curiously enough, the experiment of Prof. J. J. Thomson, in which a small pellet of mercury in an exhausted tube stopped the discharge, had its counterpart in my own experiments, as follows: I had constructed a two-way discharge tube, Fig. 2. One branch, *a*, was large in diameter and the branch *b* was of barometer-tube section. Wires sealed at *c*, *d* enabled a discharge to be passed. A small globule of mercury was placed in the tube and could be shaken down into the barometer tube and out into the large tube at will. Though the discharge would not always divide and pass through both tubes from *c* to *d*, it sometimes did; but the interposition of the mercury globule in the small tube stopped the discharge through it. Even without the mercury the discharge would often fail to pass, but reversing the coils of the Ruhmkorff coil used would often cause its derivation.

In one case, even when the mercury was in the small tube, the discharge passed, but the approach of metal objects near the tube would stop it temporarily; on their removal the discharge was resumed. This condition was so critical that it could not again be obtained, though efforts were made to obtain it. I have thought it well to record these observations, made independently, especially as the conditions were somewhat modified.

A THERMO-ELECTRIC METHOD OF STUDYING CYLINDER CONDENSATION IN STEAM ENGINE CYLINDERS.[1]

BY PROF. EDWIN H. HALL.

THE subject of cylinder condensation is one that has always been prominent in the study of the steam engine. It is considered that in some engines as much as 25 per cent. of all the steam that enters the cylinder goes through the cylinder as water—that is, during the forward part of the stroke. Writers upon steam engineering have devoted a good deal of attention to the discussion of the cause of cylinder condensation, with perhaps less attention to suggestions for remedy. The cause of cylinder condensation is this, that when the cylinder is thrown into communication with the condenser, rapid evaporation takes place of the water remaining on the wall, and that rapid evaporation under the diminished pressure cools greatly the cylinder wall.

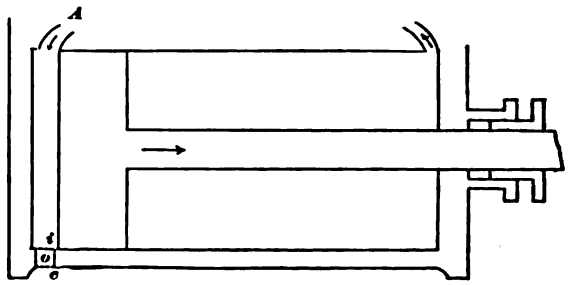

FIG. 1.

I know that steam engineers are by no means in agreement as to what caused the cylinder condensation, some believing that the steam coming in here at A, Fig. 1, was cooled by contact with a layer of water remaining over from the previous stroke—the layer of water upon the inside of the cylinder. Knowing the pressure at this part of the stroke, *c*, Fig. 2, and the volume occupied by the steam, we can tell what weight of steam there is in the cylinder as *steam*. It is found frequently that there is more steam in the cylinder at the end of the stroke than at the beginning of the expansion. According to Mr. Dickerson, in a paper read before the Electric Club, of New York, this was due to the leakage by the valves by which steam was admitted, when the pressure in the cylinder fell low. It seemed to me that we might test the question how much heat enters the cylinder wall by a thermo-electric method. Let *e i*, Fig. 1, represent the thickness of the cylinder wall; *o*, is a hole about ¾ of an inch in diameter; the thickness of the wall is about ¾ of an inch. Screwed into the hole is a plug, Fig. 3, having at the end a slice of iron, *s*, of known thickness.

It being my purpose to find what the temperature was at a particular depth in the iron at a certain point of the stroke, I wished to have that temperature as exactly as possible what it would be if the iron were in a normal condition—that is, if this were in a solid cylinder instead of being in a prepared plug. To get that I found it necessary to have a heat conductivity which was more nearly like that of iron than the heat conductivity of antimony and bismuth, which were first tried. Nickel and iron make a very good thermo-electric pair. Fig. 3 is a plug with a hole bored completely through it. There is a slice of cast iron, S, ground to a particular thickness, which is screwed on at the end of the plug, making a steam-tight joint.[2]

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[1] Abstract of a paper read at the General Meeting of the American Institute of Electrical Engineers, New York, May 20, 1891.

Into this hole is put a core of nickel insulated from the iron except where it strikes the slice. The nickel is soldered to the iron.

The distance from the outer end of the core to the farther surface of the slice was measured carefully before soldering, and after soldering. In no case did these measurements show the thickness of the solder to be as much as .02 mm.

We know very definitely, then, the depth at which the contact takes place. By experiment, I found that the heat conductivity of nickel is perhaps 15 or 20 per cent. less than that of cast iron,[3] but still nearer the heat conductivity of cast iron than any other metal that I could get that would make, with iron, a good thermo-electric junction. The specific heat of nickel is near that of iron, which again is as important, perhaps, as the matter of the thermal conductivity. Now from the nickel core I lead a nickel wire, both being made from the same bar of which I had determined the conductivity; and from the iron an iron wire. This and the one of nickel were slender bars, about 15 cm. long. These junctions *i* and *n*, Fig. 3, are put in a pot of paraffine, and I go through the processes which I have indicated already, and connected to a galvanometer. The paraffine is then heated, and when the temperature of the two junctions *i* and *n* are the same as those in the plug I N the current will cease. But a current is manifested when the respective junctions are at different temperatures. In my latest experiments the fly-wheel made about 60 revolutions per minute, and contact lasted about $\frac{1}{60}$ part of a revolution. A cam pushes two pieces of brass together without touching either of them directly.

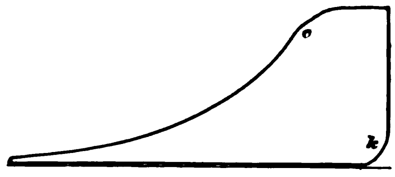

FIG. 2.

I had three plugs like this made. With one the slice of iron was half a millimetre thick (.051 cm.); with the other, a millimetre thick (0.101 cm.); with the other, two millimetres thick (0.203 cm.) Let Fig. 2 be the indicator card from the engine with which we are making this test. I used first the plug with the thinnest slice, and found the temperature at half a millimetre at that part of the stroke, K, Fig. 2, just before steam is admitted. I did the same with the millimetre slice and with the two-millimetre slice. Let the line D, Fig. 4, represent 4 mm. of the thickness of the cylinder wall, points at depths of ½, 1, and 2 mm. being marked upon it. Suppose that distances to the left from the line D represent excesses above 109 degrees (109 degrees centigrade being the temperature of the outer surface of the cylinder wall). With the half millimetre slice at the part of the stroke, *k*, I found an excess above 109 degrees of 8 or 9 which I will represent by the distance *a*. With the millimeter slice I find the temperature to be greater at this part of the stroke, and the excess above 109° being represented by the distance *b*. With the two-millimetre slice the temperature was not very different from what it was with the one millimeter. Through the tops of the lines *a*, *b*, and *c* I draw a curve.

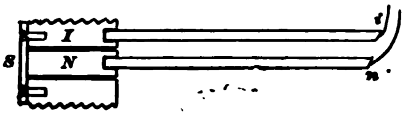

FIG. 3.

I make similar determinations for that part of the stroke *c*, Fig. 2. I find the temperature at half a millimetre depth has risen to 131 degrees more or less. The temperature at a depth of a millimetre is a little higher. This point, ½ mm. deep, has already begun to cool. The fact is that in my engine the cut-off is, like Fig. 2, pretty gradual, so that re-evaporation very likely begins before cut-off is complete. I suspect, however, that 131° is too low for the temperature at a depth of ½ mm. At the depth of two millimetres the temperature is not as high as it is at a depth of 1 mm. At a depth of two millimetres in the iron there is, however, a jump of some 4 or 5 degrees centigrade.

The inner curve, Fig. 4, represents the condition of things at the part of the stroke *k*. The other curve represents the condition of things at that part of the stroke *c*. The curves are by no means accurate, and they are very incomplete; but supposing them made perfect, I have merely to put on a planimeter to measure the area between those two curves, and it is then easy to determine how much the heat in the cylinder at the part *c* of the stroke exceeds the heat in the cylinder at that part *k* of the stroke, and this excess of heat is the heat which has been given up by the steam to the cylinder-wall, which has been done during the admission. Allowance should be made, of course, for the loss through the wall meanwhile. Then I compare that with the indicator card and see whether the two are in agreement.

I have made some tests for points at other parts of the stroke. I found that at a half millimetre depth the temperature at cut-off has already passed the maximum, that it falls rapidly during expansion, and at the part of the stroke near release it is only a few degrees higher than at the end of the exhaust. But the parts deeper in the cylinder are, of course, slow to cool. In fact, the heat rushes into the wall during admission; then, as soon as the pressure is relieved, the water begins to evaporate from the inner wall and the heat ebbs back, and is spent, some part of it, in forming steam during the expansion, but not all of it; a considerable part remains at the end of the stroke, to be spent in evaporating water, which is still clinging to the wall of the cylinder. As I have said, this research is by no means complete, but it has gone far enough to indicate that a very large quantity of heat goes into the cylinder wall. A very rough calculation from my experiments indicates that in the engine I am using,[4] according to the best estimate I can make, probably two-thirds as much steam is condensed upon the cylinder wall as remains active at the beginning of expansion. I should say that one-third probably of all the steam that enters the cylinder is condensed upon the cylinder wall upon the first quarter of the stroke. How much of that is re-evaporated during the stroke, and so helps, more or less, I not yet know. According to the indicator cards taken during the experiments with the plugs the weight of steam in the cylinder at the end of expansion is about 1.25 times as great as just after cut-off. How much heat is absorbed by the layer of water which remains over from the previous stroke I cannot tell. I think there is some evidence that a layer of water does remain over from the previous stroke. This examination shows, however, that the iron is exceedingly effective in cylinder condensation, and it suggests

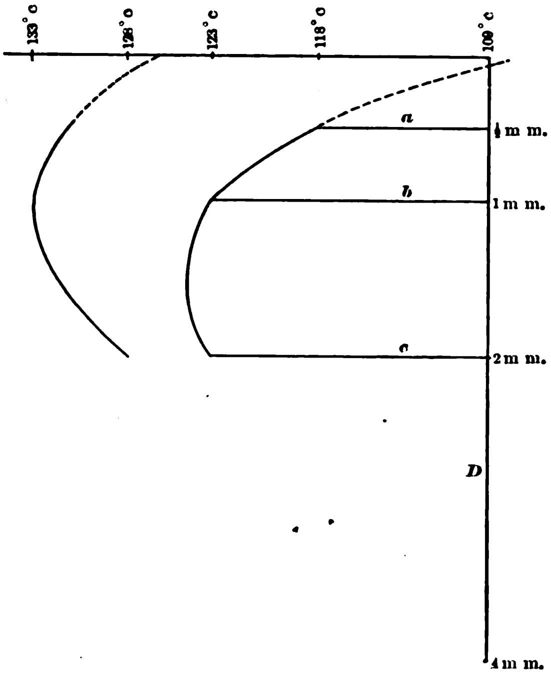

FIG. 4.

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[2] In some of the experiments this joint was not perfectly tight, for *water* was sometimes seen to come out by the *core* N before the plug became hot. Generally upon such occasions the leaking appeared to cease when the plug became hot. The fact probably is that the joint continued to leak slightly, but leaked *dry* steam, the temperature at the outer end of the plug being about 109° C., and at the inner end considerably higher. Both experiment and reason indicate that the effect of such leakage upon the temperature found was slight.

[3] The nickel used was of fair commercial quality. I am not yet prepared to publish details of the measurement of its conductivity.

[4] The engine is a Kendall & Roberts, 10 inch cylinder with 15-inch stroke. This maximum pressure is about 33 pounds (above atmospheric) with an expansion of about 4—not quite that (about 3¾)—and about 60 strokes to the minute.

the question whether it is not possible to coat the inner wall of the engine or the cylinder heads with something which would prevent, to a considerable extent, this condensation.

The research of which I have here given an account has been carried on with money from the Rumford Fund of the American Academy of Arts and Sciences. For indispensable assistance in the investigation I am indebted to Messrs. Barron, Curtis, Hale, Kendrick, and Page, members of a class at Harvard College engaged in a study of the steam engine.

THE EDISON KINETOGRAPH.

In addition to the account already published in The Electrical Engineer of the Edison Kinetograph, which is attracting such widespread public, as well as scientific, interest, we are glad to give our readers the following description, taken from the excellent article of Mr. George Parsons Lathrop in *Harper's Weekly*. After giving a résumé of previous achievements in instantaneous photography and the events which led to Mr. Edison's invention, Mr. Lathrop continues:

"The kinetograph reproducer now in use at Edison's laboratory (Llewellyn Park, Orange, New Jersey) is regarded only as the basis for still further development. Photographs are taken first from a living person in active motion. This is done with a camera regulated by electricity, having a mechanism and other details of preparation specially devised for the purpose.

"The photographic impressions are received through it upon a thin gelatine band which runs along with prodigious rapidity behind the lens. Taking 46 pictures in a second, it would take in one minute 2,760, and in one hour 165,600 of them. With the pictures an inch wide and spaces of an inch between, it must travel 7⅔ feet in every second. But since the strip is at rest during nine-tenths of the second, the passing of these 7⅔ feet is really all done in *one-tenth* of a second. That is, the strip, when it does move, goes at the rate of about 50 miles an hour. It receives a perfect photograph of the moving figure in a small fraction of a second. The shutter closes and opens like a flash, and the gelatine band receives on another spot another perfect picture. A point of the utmost importance is this: *only one forty-sixth of a second* can be allowed for the whole process of taking a photograph *and for also moving the band along a certain distance*, so that it will be ready for the next impression. It is essential to expose the band to the light for the longest possible part of this fraction of the second. To give it such exposure as to obtain a distinct image, yet carry it forward quickly enough to receive another and another, up to the number of forty-six, was perhaps the greatest difficulty which the inventor had to overcome.

"The main features of the reproducing mechanism are not difficult to describe. Fig. 1 shows the simple device for unreeling the photographed film from one coil, marked A, and carrying it up over the wheel B, past the aperture in the shutter and box at E. As it runs on beyond that point it is caught by numerous little teeth on the wheel to the left, *i.e.*, C, controlling the motion of the strip, and giving it an exact uniform progress. Finally, the strip is carried downward and coiled again for future use on the reel designated by D. The compartment L contains the illuminating bulb, fed by wires from below, and a small electric motor, specially made for this machine, supplies the needed power. In Fig. 2 the arrangement of the strip and of the shutter between it and the glass opening is outlined more in detail. The shutter is circular, and in both diagrams is lettered S S. Fig. 2 represents it as though we were looking down upon it vertically, with the gelatine strip B B lying flat under it.

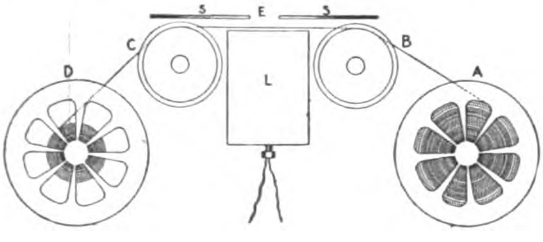

Fig. 1.—The Edison Kinetograph.

"Now in the circular shutter there are four openings 1, 2, 3, 4, and it is so completely connected with the strip-moving mechanism as to act in perfect unison with it; so that when the shutter revolves these openings one after another are brought opposite to and over one of the small pictures on the strip. As that picture glides on away from the aperture the solid part of the shutter in the same fraction of a second intervenes between us and that blank space on the strip which separates every picture from the next. So through the shutter openings we behold only the flying photographs, and none of the blank portion of the gelatine strip or ribbon. It is in this way that we receive a continuous pictorial impression; and as each photograph slightly varies from the rest, they impart to our continuous impression a convincing illusion of life-like movements. The usual and most effective manner of using the kinetograph will be to project the figures from this lens, greatly enlarged, upon a screen, where they may be shown, if need be, as of life-size.

"It should be borne in mind that each time the gelatine band is arrested so as to receive an impression through the camera lens it must 'stop dead.' It cannot be allowed to vibrate or move, for if it stirs at all the photograph will be shaky or blurred, and its usefulness for enlargement be destroyed. The little picture when thrown up to life size is magnified 57,000 times; therefore to have any value when so greatly enlarged it must of course be perfectly clear and accurate. This compels the use of very sharp lenses; and the gelatine band must also be peculiarly sensitive in order to register the impression quickly yet sharply.

"There is a different sort of kinetograph recorder which has not yet been shown, even experimentally, in which the recorder contains a revolving cylinder like that of the phonograph. Only, instead of wax, it will be made of highly sensitized glass; and upon it, while it turns, there will be taken a series of photographs one twenty-thousandth of an inch square each—*i.e.*, invisible to the naked eye except as very small dark spots. These will impress themselves on the glass cylinder in a continuous spiral line, like that of indentations upon the phonograph's wax. The cylinder will have a reproducing attachment corresponding to the phonograph reproducer, but, in this case, consisting of a microscope. So while the cylinder turns upon its axis one may gaze through the microscope and have the whole action which has been imprinted on the spiral series of microphotographs unrolled before him, the figures in motion and enlarged to cover the field of the microscope."

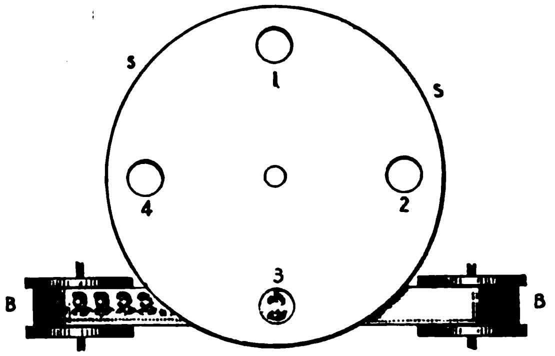

Fig. 2.—The Edison Kinetograph.

Society and Club Notes.

FIRST SMOKING CONCERT AT THE ELECTRIC CLUB.

The entertainment given at the club on Thursday night last, though somewhat in the nature of an experiment, proved very successful, and the first smoking concert bids fair to lead on to a number of enjoyable evenings of the same nature. The concert was given in the parlors of the club, a small platform being built at the street end, while down through the rooms were a series of tables equipped with "churchwardens" and shag tobacco. The Messrs. Steinway generously favored the club with the loan of a fine grand piano. The programme was opened with a piano solo from Massenet's "Le Cid," by Mr. G. M. Phelps, who was followed by Mr. C. McL. Paine, in the "The Daily Question." This song brought as an encore a beautiful new song by Mr. George H. Guy, "Love Comes Nevermore," fitted to words by the late Philip Bourke Marston. Mr. R. Varley then gave, on the violin, a "Romanza" by Carl Bohn, and one of Moszkowski's "Spanish Dances." Mr. M. J. Sullivan gave a musical recitation "On the Banks of the Rappahannock," an incident of the Civil War. Mr. Guy next aroused great enthusiasm by his "Magyar Dance," dedicated by special permission to Mrs. Kendal, and now played for the first time in public, by himself. The members showed themselves very appreciative of the compliment and of the very pretty dance itself. An aria from Bach followed, by Dr. Leonard Waldo, violincello, Master Waldo, violin and Mr. Phelps, piano. The first part closed with a clever phonograph recital by Messrs. M. C. and M. J. Sullivan. After a brief interval, Master Waldo sang with much taste, Robaudi's "Bright Star of Love," with 'cello obligato, by his father. Then came Mr. Paine whose well trained tenor voice did justice to another new and taking song by Mr. Guy, entitled "Exiled." Mr. Varley gave Raff's "Cavatina" on the violin, and Mr. R. F. Outcault with the help of Dr. Wangemann at the piano and of his own banjo, brought down the house with his electro-topical song, "In Other Respects We Are Doing Quite Well." Mr. F. R. Colvin then gave some waltz music, and the phonograph closed the proceedings, which filled nearly three very happy and pleasant hours.

THE TELEGRAPHERS' BROTHERHOOD AND THE RAILWAY TELEGRAPHERS.

A SPECIAL dispatch from St. Louis, of June 18th, says: "It is practically settled that the Telegraphers' Brotherhood and the Order of Railway Telegraphers will amalgamate, and that one order will be taken into the Federation of Railway Employees. There has been very strong opposition to this, and this opposition at one time went so far as to threaten injunction proceedings. A secret conference was held last night, and the clause prohibiting strikes was eliminated from the constitution in order that the order might go into the Railway Federation. A majority of the delegates to the Railway Telegraphers Convention were in favor of joining the Railway Federation, but many did not want to amalgamate with the Brotherhood.

"This morning telegrams were received from both F. B. Sargent, Chief of the Brotherhood of Firemen and President of the Supreme Council of the Railway Federation, and from George Howard, Chief of the Conductors' Brotherhood, stating that neither the order nor the Brotherhood would be received into the Federation as separate bodies. "Unite and then come in" was the purport of the messages. This was the situation when the convention met to-day. The sessions are secret, but it can be definitely stated that the proposition to change the constitution was adopted by a vote of 115 to 12. Then a committee was appointed to confer with a committee of the Brotherhood" The conference failed of its object, however, and the two bodies still remain apart, though friendly.

ANNUAL MEETING OF THE RAILWAY TELEGRAPH SUPERINTENDENTS.

The Association of Railway Telegraph Superintendents held its tenth annual meeting at Cincinnati, O., on June 17, President G. T. Williams in the chair. Thirty-six members were present and twenty-one new members were elected. Mr. Chas. S. Johes, of the Illinois Central, was elected president, L. H. Korty of the Union Pacific, vice-president; P. W. Drew, was re-elected secretary and treasurer. The association was invited to hold its next annual meeting at Denver, and voted to do so on June 15, 1892. Mr. E. St. John, general manager of the Chicago, Rock Island and Pacific Railway, promised free transportation both ways to members and ladies. Messrs A. R. Lingafield, C. G. Sholes, and F. M. Duncan were appointed a committee of arrangements for that meeting.

The annual dues were raised from $3 to $5, after the current year.

Mr. G. H. Lang read a paper on the "Care and Maintenance of Electric Block Signals," after which Mr. W. B. Leonard spoke highly of the results obtained with the phonoplex. Mr. U. J. Fry then read a paper on the quadruplex, bringing out various ways of utilizing it in railway service. Mr. C. Selden, in the discussion, told of his experience in 1869 at Cincinnati, when, with Mr. E. T. Gilliland, he was applied to by Dr. Nicholson for a polarized relay. The claims of Dr. Nicholson were afterwards recognized by the Western Union Co., and he received compensation from the company for his quadruplex.

Exhibits were made during the meeting by the Hall Signal Co.; the Gill-Alexander Electric Manufacturing Co.; the Electric Secret Service Co., of New York, who exhibited their ingenious individual call and selecting mechanism; the Union Switch and Signal Co.; the Edison Phonoplex; Wm. Marshall, condensers, the O'Neil and the Chase automatic highway crossing alarms; W. P. Ward, working repeater set; I. N. Miller, protector for telegraph and telephone instruments, and the Dennison automatic telegraph, reproducing autographs, drawings, etc., in fac simile.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

Mr. J. I. Gulick, Chairman of the Committee on Exhibits, has issued a circular to the manufacturers of, and dealers in, electrical apparatus and supplies, inviting them to participate in the exhibition which is to be given in connection with the convention at Montreal. We trust that this invitation will be very generally accepted. The convention will last from September 7 to 11, and it is proposed to carry on the exhibition from September 7 to 16. The large Victoria Skating Rink, 228x110 feet, has been secured for the purpose, and if crowding renders it at all necessary, a large marquee will be put up in the grounds adjoining. The committee hope to arrange for the admission of exhibits into the Dominion free of duty, that is, the duty only being payable if the goods are sold. With the circular go application blanks for space to be filled out and returned to the secretary at 136 Liberty street.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, *150 Broadway, New York city.*

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

I WOULD call the attention of your readers to the statement of my position in regard to lightning protection, as made in my paper read before the American Institute of Electrical Engineers, April 21st, which reads: "I would thus formulate what seems to be true—that a conductor which can be easily dissipated by a lightning discharge, protects the building to which it is attached between two horizontal planes, the one passing through the upper end of the dissipated conductor, and the other through the lower end; and it is this one point that I would urge upon the consideration of the Institute." Above the upper end, or below the lower end, of the dissipated conductor there may be damage, but a very careful search of the records has as yet brought to light no case of damage on the same level as the dissipated conductor.

The truth of this could not be better shown than in the case of the church tower at Newbury, Mass., referred to by Mr. C. J. Hubbell, in your issue of June 17th, which is described at length, in Franklin's own words, in my paper. The details of the other cases mentioned by Mr. Hubbell I have not been able to find in my search at the Astor Library; as given in Anderson's "Lightning Conductors, "they have no value as evidence for, or against, my statement, which I believe to be a physical law.

The evidence in my possession of the truth of my proposition in regard to the perfect protection furnished by a dissipated conductor within the limits named is so strong that I no longer have any doubts; but I hope that this question of fact—for I have no theory—will be freely discussed in your columns to the end that the truth, whatever it may be, shall be known, only asking that there shall be a careful avoidance of illogical methods such as were employed by one of the speakers at the Institute meeting.

N. D. C. HODGES.

NEW YORK, June 19th, 1891.

Financial Market.

QUOTATIONS ON ELECTRICAL STOCKS.

F. Z. Maguire & Co., Electrical Securities, of 18 Wall street, this city, report the following quotations of June 20, 1891, from New York, Boston and Washington:

NEW YORK.

	BID.		BID.
W. U. Tel. Co.	80	Edison Gen. Elec. Co.	100
American Tele. & Cable	79	Edison Gen. Co. Def'd	....
Centl. & So. Amer	130	Consol'd Elec. Lt. Co.	...
Mexican	200	Edison Illn'g Co. N. Y.	76
Com. Cable Co	....	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	23	North Am. Phonograph	...

BOSTON.

	BID.		BID.
Thomson-Houston	48	Ft. Wayne Co.	12
" Pref'd.	25⅝	Am. Bell	201
" Series C.	....	Erie	48
" " D.	7	New England	50
" Int. Co.	....	Mexican	1.27½
Thomson Welding Co.	....	Trop. American	....
Thomson Eu. Welding	....	Edison Phon'gph Doll	....

WASHINGTON.

	BID.		BIT.
Penna. Telephone	24	U. S. Elec. Lt (Wash)	155
Ches. & Pot. Telephone	62	Eck.&Sold. Home Elec. Ry.	49½
Amer. Graphophone	5½	Ge'rget'wn & Tennallyt'wn	57

PITTSBURGH.

Westinghouse El. & Mfg. Co.	12½

Legal Notes.

EDISON INCANDESCENT LAMP LITIGATION.—III.

ARGUMENT OF GEN. S. A. DUNCAN (CONTINUED).

The next morning Gen. Duncan, resuming, said that he desired to call attention to the fact that Dr. Barker's deposition was read from a paper prepared in advance, which it was fair to presume had undergone the inspection of counsel of the Edison Company, and might therefore be regarded as a brief from the other side.

Now, he would ask, was there any invention, on the 21st of October, 1879, in putting a piece of carbon, irrespective of its shape, into a highly exhausted globe made of one piece of glass? Prof. Cross says there could have been no invention in putting a carbon wire in place of the platinum wire of the Edison lamp; no more than there would have been in substituting a superior for an inferior variety of platinum. If to-day a method were devised of making a carbon largely superior to anything that Mr. Edison has made, would invention be involved by substituting the superior for the inferior carbon? He apprehended not.

Dr. Barker, when asked what was the ordinary working vacuum in a commercial lamp, stated it was about one hundred-thousandth of an atmosphere. When asked whether a person skilled in the art wouldn't know perfectly well that in such a lamp any defect arising from a mechanical joint could be obviated by uniting the parts of the glass by fusion, he replied that such a method of obviating the defect would readily suggest itself to a person skilled in the art. In answer to further questions, he said that it was known more than twenty years ago that the best method of preserving the vacuum in an exhausted vessel was to seal by a fusion of the glass.

It seemed to them that the testimony of Dr. Barker, not to mention similar testimony of Prof. Brackett, was enough to dispose of the whole contention of the complainant, that there could have been any merit whatever in sealing up a piece of carbon in an all glass globe in October, 1879.

There were in evidence lamps illustrating Sawyer and Man's methods of sealing their receivers. Lamps had been made, which were used in the McKeesport suit, showing their method of construction; an enclosed chamber with a separate base. These had been exhausted to a high degree and run for 200 hours without impairment of the vacuum. A year later the vacuum was still intact, and Mr. Shallenberger testifies that these experiments demonstrated beyond any doubt, the entire practicability of such a structure. They illustrate the point that it was not necessary to have an all glass globe, in order to have a good working vacuum.

General Duncan said that it seemed to have been assumed in the argument addressed to the Court, and in the deposition of Dr. Barker, that the invention covered by the patent in suit created a new art, and Major Eaton, general counsel of the Edison Company (formerly its president), understands the position of the company to be that it is impossible to make a commercial incandescent lamp without infringing the patent in suit. Was that assumption a tenable one? Was it a fact that that invention, singled out from hundreds of others made by Mr. Edison, and hundreds of others made by other men, is the one thing that has created a new art, or even measurably developed an art which had existed before? Was there any evidence that this invention had ever been applied in a single commercial lamp? Was it true that immediately upon the appearance of this patent, the World recognized that the problem was solved, and that immediately thereafter lamps embodying the invention of this patent went into practical use in enormous numbers? The defendant's position was that the lamp of the patent in suit was a most inferior structure, and made in fact, no more impression upon the art than the platinum lamp of 1878. It was that worthless lamp, exhibited in November or December, 1878, that caused the great panic of gas-stocks in London. It produced a profound impression; gave eclat and notoriety to Mr. Edison, and was never heard of after a few days time, but the lamp of the patent was as worthless, according to their conception, as the earlier platinum one. There was no evidence in the record that a single tar-putty filament, spiral burner lamp, was ever made, or put in commercial use under the patent. It was not until the art had progressed beyond these two worthless things that the world began to appreciate that there was practical value in an incandescent lamp. General Duncan then read a long extract from the testimony of Prof. Chandler, taking in the feeder and main suit, showing that in his (Chandler's) opinion, it was not any of Mr. Edison's lamps that solved the problem of the electric light; it was a system of distribution for which the world had been waiting.

As the result of this consideration of the prior state of the art, Gen. Duncan said that it might fairly be concluded that Edison did not invent the burner of an incandescent lamp; a thing having a small cross-section combined with small radiating surface; nor a thing having high resistance combined with small radiating surface; nor was he the originator of the conception of high total resistance of the burner, which economically affected the question of copper in the mains; nor did plaintiffs believe it was patentable to Mr. Edison to make use of a peculiar kind of carbon which he calls "purely structural carbon;" by a process in which the operation stops when the raw material has been carbonized and nothing is done to increase its density. Nor was it patentable to reduce the raw material to shape before carbonizing it, nor merely to enclose a carbon in an all-glass highly exhausted globe.

The defendants did not believe that Edison created a new art, nor that he discovered a new physical property in carbon; and if they were right in their contention upon those points, they should argue that the only thing new to Mr. Edison, or revealed in this patent, was either his mode of preparing the carbon of the burner, leaving it in that condition of high porosity that contrasts with the old carbons and with the art; or his mode of shaping that carbon into a spiral form, or else his mode of attaching that peculiarly constructed thing to the leading-in wires. They believed that under any plausible interpretation of the patent the invention must be confined to these three matters.

Gen. Duncan said he would ask his Honor to follow him for a little in reference to the claims of the patent and the statements of invention upon which the claims seemed to resent. The term "filament" is not used until the specification comes to a burner made of tar-putty. The invention is said to consist in "a light-giving body of carbon wire or sheets." Neither term is defined in the patent. The French word for the instrument which we call a draw-plate is "filière," and "fil" is the French word for the thing produced by its use; a wire, a thing drawn through a filière; his Honor would observe the analogy between the French words and the English word filament. As the word "wire" is used six times in the patent and the word "filament" only twice, the natural conclusion would be that it is a thing which might be all the way from three or five thousandths of an inch up to a quarter of an inch or even larger. It was, of course, unnecessary to say that the third claim was limited by the precise language of the specification. Now the second paragraph in the statement of invention referred to the peculiar construction given in the first paragraph. "The invention consists in placing *such* burners of great resistance in a nearly perfect vacuum," and so on. What kind of a burner was called for by the previous section? Plainly one that was coiled; coiled not inadvertently, but in pursuance of a well-defined plan, whereby Mr. Edison proposed to secure the two valuable features of construction which he says lie at the very foundation of wide distribution of electric light on the multiple-arc principle; and if we can interpret the claim by reference to this paragraph, his invention consists in putting into that chamber such a burner as is spoken of in the previous paragraph; a burner so organized as to get that high degree of resistance which comes from coiling it, and thus making a part of its radiating surface.

There were three points in claim 1 demanding special attention. The filament is to be made of carbon of high resistance; it is to be made as described, and it is to be secured to metallic wires, as set forth. The witnesses on both sides seem to be agreed that high resistance means high specific resistance, and according to Dr. Barker, the standard by which to measure specific resistance is that of the old carbons. The question then, as regards infringment is whether defendants' burners are made of carbon as high, or higher, than the standard set up by this patent. Are they materially higher than that of carbons that were old in the art? Evidently Dr. Barker, when he gave his testimony, did not suppose that defendants' carbons were of lower specific resistance than the majority of the old carbons, and when, at length, it had been made plain to him that the resistance of defendants' carbons was just about the same as that of the old arc-light carbons, he found it necessary on redirect examination to give a most extraordinary piece of testimony. He said: "Well, a fair interpretation of that language is that the carbon of claim 1 must have a higher resistance than some of the old carbons, but not necessarily as high as others." He tells us he deliberately picked out only the lowest of the old carbons; he says he found carbons in the prior state of the art higher in their specific resistance than the carbon of the defendants' lamps. They should rely, therefore, upon the measurements made by Dr. Morton of prior carbons, in connection with the testimony given in the first deposition of Dr. Barker, in support of the proposition that defendants had no such high specific resistance as that contemplated by claim 1 of the patent. They would contend that the conditions in claim 1 were that the filament is to be made as described, and that it is to be made by "carbonization pure and simple," without any supplemental process that would induce a lowering of resistance. Gen. Duncan supported this position by numerous quotations from the testimony of Dr. Parker and from that of Mr. Edison himself. The other condition, "secured to metallic wires as set forth," in view of the language of the specification, meant the application of a carbonizable plastic material to the joint and carbonizing it in situ. He would next briefly consider whether there was any hidden meaning in the word "filament" which would be of service to the defendant. He would say frankly to the court that he did not know what the word filament meant, but he thought, nevertheless, the plaintiff was committed to certain limitations in regard to it. If the condition of 100 ohms of total resistance when in action is imposed upon this burner by the word filament, then defendants were outside the second claim as regarded two of their lamps. His brother Dyer had almost prayed the court not to construe the limitation of 100 ohms into this patent, because, forsooth, if it should, the Westinghouse Company could not be prevented from going on with some of their low resistance lamps; the plaintiffs could not stop them; they could not kill this industry; they could not destroy the capital which had been invested here. With what grace did an argument like that come from gentlemen who had stood by for five long years, with their hands in their pockets, looking idly on and seeing this great industry grow to its present gigantic proportions; sending out circulars saying, "we own so many patents"—enumerating them—and warning the world not to infringe any of them; not saying "that patent is infringed by that lamp, and we hold you to strict accountability;" offering as an excuse for the delay, what? This: Mr. Eaton, President of the Edison Company from 1881 to 1884, says they knew of the work being done by the United States Company, but that Mr. Edison was too busy in his laboratory to justify him in giving attention to the litigation. They did not think the work the United States Company was doing was sufficient to justify litigation, and they concluded they had better wait until the business had grown to such proportions as to injure the Edison Company; they waited for five years while the United States Company was taking contract after contract away from the Edison Company. In a protest filed with the Secretary of the Treasury of the United States the Edison Company had said that "it was but equity and justice that they should have as many contracts as the United States Company" in lighting the public buildings. The United States Company took from them the contract for lighting the Capitol at Albany and many other conspicuous contracts, and all that time the Edison Company never lifted its finger to bring suit. They come in to-day, after waiting all those years, and say, "Your Honor, don't impose upon this patent the interpretation that the burner is limited to 100 ohms, because if you do, with the methods of distribution known at the present day (although not known then), the Westinghouse Company cannot be stopped." It was not necessary either, according to the contention of these gentlemen, that if the Westinghouse Company was to be killed it should be with this particular club. They had patent 227,229, with a broader claim than this, and other patents, hundreds of them. Logically, therefore, it was not necessary, if that be a legitimate object on their part, that your Honor should sustain the patent on any particular interpretation. Does "filament" mean a burner whose resistance hot is 100 ohms? That is the lowest resistance spoken of in the patent. It had been abundantly established by the testimony of the experts that with any method of distribution known at the date of the patent large numbers of lamps could not have been operated in multiple arc except with a resistance at least as high as 100 ohms hot. This could be accomplished with more recent methods, but the specification must be interpreted now with reference to things then known. Mr. Edison had said in his testimony that his calculations showed that the lamps must have at least 100 ohms resistance to compete successfully with gas. For these reasons, said Gen. Duncan, defendants concluded that the term filament was understood by Mr. Edison to mean a thing having a resistance hot of not less than 100 ohms. What else it may have meant was a mystery to them. They had received no light from the experts, nor from the brief, nor from the argument of plaintiff's counsel. The term never appeared in the art of electric lighting until embodied by Mr. Edison in this patent, and under every obligation which the law imposes upon an inventor seeking the wide protection of the statutes he was bound to define that term with exactness, so that those who did not want to make that thing, but something else, should know what territory was occupied, that they might keep on public land. He had given them a document uncertain, vague and indefinite, and they did not know how to act in relation to it. Left in that condition of uncertainty, they had to do the best they could to find out whether there were some limitations to be imposed upon it. Another definition which it seemed it might be sought by plaintiff's counsel to impose upon the term, that a filament is a thing so small in cross-section that the platinum wire conveying current to it can be sealed into the globe by fusion. They had been told that the old "rods," as Mr. Edison chose to call them, required a wire so large that it could not be effectually sealed into the glass. Here, said Gen. Duncan, is an exhibit, showing seven carbons running from an extremely tenuous one up to one quite thick. Now those largest burners were practically larger than any used in incandescent lamps of the present day. Here, for instance, were a couple of old Sawyer and Man carbons very much smaller than some of those shown in the exhibit (exhibiting). There is a Bernstein lamp and there a Thomson-Houston lamp; they are series lamps, and show burners which he supposed Brother Dyer would say were filaments because they were not rods; perhaps he would say they were rods because they were not filaments, but they were quite large, and he did not know why they should not be called "rods" or not be called "filaments."

Gen. Duncan said he would next pass to the consideration of a certain application filed by Mr. Edison in the Patent Office a little later than the issue of the patent in suit. While the application for the patent in suit was pending Mr. Edison had filed what is known as the "paper-carbon application," in which he had described a burner of paper, and sought to secure a patent on it. A long interference controversy with Sawyer and Man followed, and the latter obtained, as a result of that controversy, the patent that was before Judge Bradley, at Pittsburgh, in the McKeesport suit. Subsequent to the date of the patent in suit Mr. Edison divided off from that application a portion not involved in interference with Sawyer and Man and filed a divisional application, which, having undergone various modifications, is still pending in the Patent Office. It came to the belief of defendants that claims co-extensive with those of the patent in suit, under the interpretation the plaintiff is undertaking to impose upon that claim, were contained in that application. They had called upon the plaintiffs to furnish a copy of that application; they had declined. After various applications to the Commissioner of Patents and to the courts, Judge Lacombe finally had said to the plaintiffs: "You must produce the retained copies of those papers.' Eventually they had been shown and put in evidence. There was very good reason for the plaintiffs withholding the papers; they (the plaintiffs) felt that it was a critical point in their case, and they fought it for a whole year with all the vigor of the able counsel employed to aid them. Among the claims in this application were the following:

"An electric lamp for giving light by incandescence, consisting of a filament of high resistance and flexible carbon hermetically sealed within an enclosing globe made entirely of glass, substantially as hereinbefore set forth."

The Patent Office had rejected the application as not presenting anything patentable over the patent in suit. They did not take the rejection graciously, but said that the claims presented covered vital improvements and advances in the art which had made Mr. Edison's system the success it was. His inventorship had not been disputed and he was entitled to protection therefor. "The invention covered by that patent," said they, viz., "a certain incandescent electric lamp, does not form the essential features of the invention such as is now specifically claimed." To which the Patent Office replied that the claim of both the patent and the application were for substatially the same invention, viz., a high-resistance carbon. Mr. Edison said no, the Edison Company said no. The specification and claims had been drawn by the attorney of the Edison Company; the case was prosecuted by the Edison Company; when he said Mr. Edison he meant the Edison Company. They had made declarations to which defendants could appeal for the porpose of interpreting the patent in suit. They were not satisfied with the declaration of the examiner, and they denounced him later in plain terms. They said: "The claims recite matters of invention original with Mr. Edison; they are useful and important, lying at the very base of the past two years' successful development of incandescent lighting. Mr. Edison, under the law, is entitled to protection therefor. He has not that protection in the patent referred to. It has not been attempted to get that protection in that case. He cannot legally obtain it by reissue of that case. This application is the way to obtain it under the decisions of the court and the Commissioner, and upon the allowance of this application I must insist." A long correspondence followed, in which the office took the position that if Mr. Edison was not entitled to make the claims in a reissue because the public would be defrauded of some of its rights, he was certainly not entitled to claim it in a patent which would cover the same ground as a reissue, and continue two or three years after the original had expired. Gen. Duncan thought his Honor would find, as Judge Lacombe found, that this document was very material to the interpretation of the patent in suit. Not only did this application throw a bright light on the proper interpretation of this patent, but it threw a strong side light upon the laches of the plaintiff in bringing suit. He had referred to the competition that was going on from 1880 to 1885, when this suit was filed The complainants had looked on and said nothing. Major Eaton says the reason was that the defendants were not doing them enough harm; that was simply childish. The explanation of that delay was to be found right here. The Edison Company did not believe during those years that the patent now before the court was the fundamental patent which they now assert it to be. They did not bring suit until that application in the Patent Office had drifted into that position where they felt powerless to secure what they originally asserted under it to be their rights Then they said: "We have nothing to lose by taking our chances on patent 223,898." (At this point the proceedings were adjourned for the day.)

On Monday, June 1st, at the opening of the court, Gen. Duncan resumed his argument, and proceeded to discuss the question of jurisdiction as affected by the statute relating to the limitation of the term of an American patent by a prior foreign patent; which, being a matter of purely legal rather than of technical interest, has been omitted.

In conclusion, Gen. Duncan said that the contention of the defendants in regard to the patent was that it did not meet the stern requirements of the patent law. Mr. Edison did not in his patent describe the invention in such terms as would enable a person skilled in the art to make and use it, nor the best mode in which he had contemplated applying the principle of his invention; nor did he particularly point out and distinctly claim, as required by the statute, the things which he claimed to be his invention or discovery. There was absolutely no definition of the term filament in the patent, and complainants' experts have shown themselves to be utterly incompetent to define it. So of the word carbonization; the patent has not undertaken to specify what that term signifies. What did Mr. Edison mean by carbonization? If but one method was known to him at that time—the old method by the furnace—and that would not answer in dealing with the tar-putty filament which he describes as the best mode of carrying out his invention; then the patent failed, because it was not operative. Mr. Howell had been obliged to resort to a method of carbonizing in order to make his test lamp, which was not known to the art at the date of the patent in suit. Mr. Edison has said in the most explicit language, that electrical heating in a vacuum is carbonizing; that the preliminary work was not carbonizing; it was only charcoaling, and that the real carbonization was done when the electric current was put through the carbon.

It came, therefore, down to this point: Upon the testimony of Prof. Thomson; upon the experiments made by Mr. Howell by the plaintiff; it stood practically confessed by the Edison Company as impossible under this patent to make the thing described, without resorting to practices not known to the art at the date when the patent issued. If Mr. Edison knew that electrical carbonization on the pumps was necessary in order to make a serviceable carbon, he was bound to put it into his patent. Defendants would say further, upon his own testimony, that he did know; because when asked how long he had been carbonizing his burner by that method, he replied, From the very beginning; then he was asked whether the very first lamps made by him in 1879 were so carbonized, and he said, "Yes." Thanking his Honor for his patient attention, he would now yield to his associate.

ARGUMENT OF CLARENCE A. SEWARD, ESQ., FOR THE EDISON CO.

Mr. Seward said that the several large volumes which constituted the record in the present case were, to phrase it mildly, professionally repellant, and he did not know but that they might be judicially repellant also. His friend Mr. Duncan, even in the zeal of his presentation had suggested that he did not expect his Honor to read, page by page, the 5,000 pages which constituted this record. This prolixity had arisen from the fact that the professional experts, sometimes called by the authorities "auxiliary counsel," had here met with professional gentlemen almost as expert as themselves. When, therefore, these experts were upon the stand, they had advanced theories, and had submitted to be cross-examined to sustain theories to an extent which was wearisome, cumbersome, and not enlightening in reference to the two questions which actually present themselves for adjudication. One of these was, is the Edison patent valid? and the other, did the defendants infringe it? Those were the two questions of fact; whether the patent was valid upon its face, whether it described sufficiently the modus operandi, the construction or other purpose for which it purports to have been issued; these would be discussed by his brother Lowrey, but he wished to call his Honor's attention to one statement of the Supreme Court, to wit:—"Experts may be examined to explain terms of art, but cannot be received to prove to the court or jury what is the proper or legal construction of any instrument or writing. A judge may obtain information from them, if he desires it, on matters which he does not clearly comprehend, but cannot be compelled to receive their opinions as matter of evidence." Hence much of this record would disappear, not containing matters of evidence with which his Honor need trouble himself, but only expressions of opinion from "auxiliary counsel." These expert depositions, occupying so much of the record, invited an excursion into the electrical field too broad for him to attempt to cross. There had been assigned to him (Mr. Seward) a question of fact, and such answer as there might be to the questions of law presented by the defence. He desired first to submit some general views of the case indicating the drift of the inquiry to be made by the court. He submitted with some confidence, that his Honor had not been shown, either in the art or in antecedent patents, one which covered this invention with the exception, as he would hereafter show, that he would be expected to find the invention of Mr. Edison, in the Sawyer and Man discoveries, inventions, patents, labors and experiments. On the question of utility, the patent itself was *prima facie* evidence, and so was every incandescent lamp ever used; somebody had evidently made an invention which rendered incandescent lighting possible, and who ever made it ought to have the credit of it. Every successful lamp had a burner of filamentary formation, small in cross-section and radiating surface; of high specific resistance; of sufficient stability to resist disintegration to an extent rendering a lamp useless; having sufficient elasticity to resist shocks, and capable of expanding by heat without injury to its substance. Such a burner was placed in a permanent vacuum in an all-glass chamber, and connected to platinum wires leading out to the wires which supplied the current. Each of these features had been purposely originated by Mr. Edison, or by him selected from the arts as a unit for his intended combination. By this invention, for the first time, the practical subdivision of the electric light, and its use in multiple arc had been successfully accomplished. Did Mr. Edison make this invention? If he did, his patent was not obnnoxious to the criticisms which had been made upon it. It was valid because he was the original and first inventor of that which usage demonstrates to be useful. No one else had claimed to have been the inventor of this lamp except Sawyer and Man. What was it that had been needed in all the prior lamps to make any one of them a successful lamp? The complainants contended that it was Mr. Edison's filamentary burner of carbon, arranged and combined as he arranged and combined it in his patent. His Honor would find in all this voluminous record, no allusion to a filamentary burner combining high specific resistance with small radiating surface. It had not been described, nor known, nor produced. The fact of success in incandescent lighting confronted his Honor as an admitted fact, and the further question of fact for him to determine was whether such success was due to Mr. Edison's invention, or was not, and if not due to Mr. Edison, to whom was it due. No answer to that inquiry had yet been given, apart from Sawyer and Man, by his ingenious friends upon the other side. The art was absolutely silent. The complainants asserted that success was in the lamp, and not outside of it; after that success had been obtained, the field was open for improvements in dynamos, converter systems, and all else that had since been done, and only done, for the purpose of utilizing the successful lamp which Mr. Edison had given to the world. The experiment of Fontaine, which had been exhibited by Mr. Dyer, had proved that whatever had produced the perfect light in one case and the defective light in the other, had been due solely to what there was in the globes, namely, the different forms of carbon used.

He came next to the Sawyer and Man patent; that was the only resource for his Honor if he was going to find that this invention was useful, and that it had not been made by Mr. Edison, because if his Honor did not find it in Sawyer & Man, he would not find it in prior patents, in general literature, nor in specific facts. Some 900 pages of the record had been devoted to what Sawyer & Man did. According to their own statement, there were not in the years 1877 and 1878, two more intelligent, accomplished, universally read electricians than Albon Man and William E. Sawyer. They knew everything from Crookes' radiometer and the Geissler tube, down to Lane-Fox inclusive. Nothing in the whole field of electrical science, produced in experiment or handed down by tradition, nothing which had been made in France, England or America that they did not know.

The defense, upon the answer, says that the alleged invention of Mr. Edison was known to Sawyer & Man; that it had been described in their prior patents, and that Edison had surreptitiously and unjustly obtained a patent for that which had been invented by them, and that they were using reasonable diligence in adapting and perfecting the same. So that when Sawyer and Man had made their incandescent lamp, which defendants' answer virtually alleged that Mr. Edison stole, it was an invention; but when complainants put it forward as Mr. Edison's invention, then defendants say it was no invention at all; that it never rose to the dignity of an invention. Thereafter, in May, 1885, Sawyer and Man had procured for a fibrous arc-carbon in an incandescent lamp, a patent which had been applied for on the 9th of January, 1880, and upon that patent they had brought suit in the McKeesport case. They had produced here three lamps in which His Honor was to find Edison's combination and invention.

Mr. Seward then went on and read extracts from the testimony showing what Sawyer and Man did, which, as it is substantially the same as that discussed in the McKeesport case, need not be recapitulated in detail. Commenting upon the evidence, he said that the only practical question with which he would trouble His Honor was this:—"Did Sawyer and Man, in their efforts to produce a burner of any sort, succeed in producing one which could be successfully used, of a filamentary form having a small cross-section with small radiating surface and high resistance?" Referring first to the meaning of the word "filament," Mr. Seward said that to both the educated and the uneducated mind, if the latter had some knowledge of electricity it conveyed a sufficiently accurate idea of what it was intended to describe. His brother Lowrey would pardon him if the suggestion came from him (Mr. Seward) as to what he thought a "filament" was. It was a sufficient quantity of carbon to represent a word, in itself indicative of degree, having a small mass; small cross-section, and sufficient specific resistance to accomplish the purpose which Mr. Edison intended of giving light by incandescence. Anything which did that and had those characteristics, was in his judgment a filament. Quoting from the testimony in behalf of Sawyer and Man, in which it was stated, among other things, that all their carbons were treated, for the purpose of making them more dense and of diminishing their resistance, Mr. Seward said that it clearly proved that it had not been the intention of Sawyer and Man, in seeking to make a practical incandescent lamp, to use a burner with high resistance. They were not traveling in the path in which Mr. Edison was traveling; they were not seeking to do what Mr. Edison was; namely—to find a carbon which should be stable in form and would remain stable under the heat of the current. Sawyer and Man had not set out to produce Mr. Edison's carbon burner. They did not meet with it accidentally. They never made it; never used it; never claimed it; and if they did not, no one else whose name has been alluded to in connection with incandescent lighting did make, or use, or describe it.

He would next say a word or two upon the law. The argument of the defendant had carefully avoided what was really the most important law-point in the case. The position that plaintiff had so acquiesced in what defendants had done, as to lose its right to an injunction, even were the patent valid and violated by defendant, had been sought to be taken in the evidence. The patent in suit had been issued in January, 1880; this suit had been commenced in May, 1885. The only overt act charged against the plaintiff had been that it had not sooner commenced the suit. If there were anything in that defense it should have been pleaded; not having been pleaded it could not be availed of at any time or for any part of the suit. The injunction would go on or not according as his Honor found upon the issues raised in the pleadings. But as a matter of fact there had been no laches nor acquiescence. During that interval of five years the plaintiff had been under a cloud; so deep, so dense, and apparently so permanent, that even the bringing of a suit in 1885 was apparently premature. In a patent suit, which drags its slow length along, two or three years was insufficient to prepare for a contest like the one now pending. The cloud under which the plaintiff had been resting had been created by the then existing decisions, declaring the effect of a prior five years Canadian patent. Under the law as it then stood, the American patent would have expired with the five years' life of the Canadian patent. Their suit had been met with that plea, which his Honor had sustained, and it had taken two years to get through the Supreme Court with the Bate case, in which it had been decided that the patent in suit had not expired. Therefore plaintiff's suit had been premature as it was. In the meantime the defendants knew that plaintiffs had not been idle; that they had prosecuted suits in France and England, and that knowledge was known to Mr. Hebard, the president of the defendant company. His Honor would further perceive that the defence of acquiescence of necessity implied acquiescence on the part of the defendants in the validity of the patent. A man could not ride two horses in different directions at once. They might either plead acquiescence or invalidity. Mr. Seward then read from the opinion in *Williams* vs. *Boston and Albany Railroad*, to show that mere delay or acquiescence could not establish an abandonment or dedication of the patent. Mr. Seward then referred at some length to the contention of the defendants, that a subsequent Swedish patent which had been granted on its face for a term of 14 years had expired and that it had the retroactive effect to kill the prior Canadian patent, and through that to kill the patent in suit. He contended that the Swedish patent had not expired, even under the Swedish law, and that even if it had done so it would not necessarily have affected the Canadian patent. Mr. Seward also considered the defence that after the suit had been brought the complainant company had consolidated with the Edison company for Isolated Lighting and had thereby become incapacitated to prosecute the present suit. He argued that Judge Shipman and Judge Wells had already decided elsewhere, in suits commenced prior to the consolidated proceedings, that such suits had not been interfered by them in any way.

Mr. Seward said he would make one or two other suggestions, which perhaps seemed to present a point of law. Defendants had asserted that the discovery of Mr. Edison was not an invention, but a mere product and result of electrical engineering. He agreed that what Mr. Edison did was "engineering" provided that word was used in its proper sense, which he conceived to be a derivative sense. Its base or root was the Latin *Ingenium*, from which the English word word "ingenuity" was derived; defined by Stormont as "the superior power of invention." In that sense, and in exercising that power to produce this incandescent lamp, Mr. Edison was, in the highest and most impressive sense of that word, an "engineer;" one who exercised "a superior power of invention."

It had been strongly urged in the able argument of his brother Duncan, that it did not require anything beyond the application of known rules of electricity to produce what Mr. Edison had produced. Unable in their own minds, as every one was, to separate the knowledge of to-day from the knowledge of 1878, what had been done seemed to-day to be so evidently plain, simple and easy, as not to require any exercise of the inventive faculty. His Honor knew how placidly and gently Judge Blatchford conducted himself, and how seldom he employed the language of sarcasm, but in a similar case he had used these words:—"It is easy now, after the event, for scientific men to say with the knowledge of to-day that the thing was obvious, but the crucial facts contradict the assumption." What were the crucial facts here?

(1). There had been a pressing necessity for a successful incandescent lamp. The ingenuity of Sawyer and Man had been directed to gratifying it, but until Edison had given to the world his attenuated burner in a vacuum, the necessity remained unfilled. (2). The literature of the art; the record of past experiments, would have deterred any less courageous, less persistent, less confident inventor, than Mr. Edison, from making any further experiments with carbon. But he had put aside the experiment of others; the instruction derived from literature; and traveling in his own way, to his own end, he had found that carbon could be produced in such a manner that it would be stable and sufficient for the purposes of a commercial lamp, and he had given that to the world as his contribution to the science of incandescent lighting.

ARGUMENT OF MR. F. H. BETTS FOR THE UNITED STATES COMPANY.

Mr. Betts said his associates had requested him to examine the foreign decisions, and to point out how far the state of facts developed in the present record called for a different interpretation of the patent in suit at the present time. Complainants contended that all incandescent lamps made prior to 1878 were of no commercial importance; that when carbons were used they were brittle and destructible, and that the resistance of the lamps was so low as to render them incapable of being assembled in numbers with any commercial success. They pointed to the fact that the experiments of Fontaine had proved, as he conceived, that the consequent loss was so great that the scientific world had accepted his conclusion that it was impossible to subdivide the electric light He might say in passing, however, that this belief was not universal. Complainants had asserted that the lamps of Sawyer and Man had been brushed away by the decision of Mr. Justice Bradley. Mr. Seward had contended that they were of no importance, because they were of low resistance. They had admitted that in 1878 Lane-Fox had shown an appreciation of the necessities of the problem, but alleged admissions by him were quoted, as tending to show that he himself conceded priority to Edison in the production of a commercially successful lamp. He would only say in passing, that it did not appear that Lane-Fox was speaking of lamps made in accordance with the patent in suit, but of the later lamps of Mr. Edison, which were successful, for instance, the bamboo carbon lamp. Complainant asserts that the present patent describes and claims the invention which rendered incandescent lighting practicable; that Edison appreciated the neccessity, for commercial reasons, of making a burner of high resistance and small radiating surface, and that he discovered the indestructibility of carbon in high vacuum and hence used it for such a burner. On those two points, as he understood the opening argument of the complainants, this invention of Mr. Edison was supposed to rest, and the present patent, if sustained at all with a broad construction, is to be sustained on account of those two features.

Turning to the foreign decisions, his Honor would find that the course of litigation had been one of alternate success and failure. He thought his Honor would be struck with the fact that even in those decisions in which the patent was sustained it had been sustained with considerable hesitation. Mr. Justice Fry, speaking of the sufficiency of the specification had said:—"This description is so far from being as clear as it might be, that we at one time doubted whether it was not studiously and wilfully obscure, but on further consideration we are not prepared to hold such to have been the case, *especially as the point was not urged by the appellants*." The courts were also very doubtful in coming to a conclusion upon the question of novelty, in view of the earlier experiments of Swan. The carbon which Swan used was of considerably larger size than that describ ed in the Edison patent, or the one now commonly known as a filamentary carbon, yet the justices were inclined to hold that it was very much a question of mere degree in the attenuation of the carbon; if it had been wholly a question of degree he believed that they would have held the patent invalid. If the English decisions were to be regarded as of any authority upon construction, he would point out that the first claim was not infringed by the lamp involved in the present case. As to the second claim Justice Butt said that the infringement depended upon the meaning of the words "carbon filament;" if it meant a carbon filament made as described in the patent, there was no proof of infringement, but the justice held it to mean *any* carbon filament, however made, possessing certain properties mentioned in the specification; it must possess flexibility and resilience; it must be of small cross-section, of high resistance and presenting but a small surface from which radiation could take place. He (Justice Butt) was disposed to think, while refraining from a decided opinion, that the resistance must not be less than 100 ohms. The appellate tribunal had construed the claim in somewhat broader terms. Criticizing the vagueness of plaintiff is interpretation, its conclusion was that the claim ought to be construed with generality, and hence might be paraphrased as a claim to every combination of any carbon filament with any receiver entirely of glass through which leading wires passed and from which the air was exhausted. The qualification of Mr. Justice Butt that the filament must be one that has flexibility or resilience was apparently disregarded. The court had considered that high resistance was an essential feature, for in the prevailing opinion of Mr. Justice Fry he had said:—"Mr. Edison used a filament instead of a rod for a definite purpose, and by the diminution of the sectional area made a physical law subserve the end he had in view. The smallness of size, therefore, was no casual matter, but was intended to, and did bring about a result which the rod could never produce, and so converted failure into success." He (Mr. Betts) thought that was as forcible a statement as could be made of the argument in favor of the patentability to Edison of the feature of high resistance in the filament. But then immediately came this trouble :—Does it mean high *specific* or high *total* resistance? If it was contended that it was high specific resistance, the discussion might as well stop where it is, for the whole case might be easily disposed of. Of course, complainants could not insist that a burner had high specific resistance merely because it is of carbon. Any burner of carbon was of high specific resistance as compared with one of platinum. But Edison could not claim each and every burner of carbon in an exhausted glass vessel, for that was all. If high specific resistance was essential, it must mean that it was due to some particular kind of carbon, which had, relatively to other kinds, high specific resistance. If that were the contention, and it seemed to have been emphasized by his brother Seward all through his argument, there was no need to discuss the case further, for defendants did not use burners or carbon of high specific resistance. If the Edison patent was construed to be for a lamp with a burner of a particular carbon that has high specific resistance, then defendants' lamp did not contain that carbon. As pointed out by his brother Duncan, he thought there was strong ground for saying that the Edison patent did mean that very thing. If they took Edison's words, his plain statements, and gave them their legitimate interpretation that was what his patent was limited to, and that was what the defendants did not use. He thought, however, that that was not the meaning of the English court. They considered that the filament must have great total resistance to achieve commercial success, but then they were immediately met with the question, What was "high" total resistance? It could not mean high resistance relatively to the circuit, because every prior lamp, from the very law of its operation, must have had a burner of high resistance, relatively to the rest of the circuit. Did it mean high resistance, in the sense of being relatively higher than the old lamps mentioned in the patent? It might be contended that the English court thought that Edison meant to include all lamps having a higher resistance than 4 ohms. In that sense a lamp with 5 ohms or 10 ohms resistance would be a high resistance lamp. The difficulty about that construction was, that Mr. Edison was mistaken if he supposed that no lamps had been described having more than 1 to 4 ohms resistance. Mr. Betts then read from the Sawyer and Man patent of 1878, pointing out that the whole subject of arranging lamps, both in multiple arc and in series, had been there described, and the use of lamps having 10 ohms of resistance referred to. He cited this patent to show that Edison could not say that every lamp of more than 4 ohms resistance was a "high resistance" lamp. What other definition was left of high resistance? Only this: that the resistance should be *so* high as to enable the lamps to be commercially used in large numbers in multiple arc, and that meant substantially in figures, as proved on both sides of the case, that each lamp must be 100 ohms. He thought that was the meaning the English court put on the term of high resistance in the English patent. Certainly it had been so in the first case before Mr. Justice Butt, and on appeal. It seemed to him that in the second decision the court had felt that there was much difficulty about the question and that it was simply a question of degree. The justice who pronounced the prevailing final opinion on the final case defined the term "filament" as a carbon which had been bent before carbonization into the required form, and had been carbonized while so bent. In other words, it had been held that the patent should stand when limited to a carbon filament made in a particular way. He thought it was doubtful whether the defendants would infringe on any such construction as that.

The defendants' carbons were not bent, but were stamped out of sheets by dies into the forms desired. Whether or not this was the equivalent of bending, would be for his Honor to determine. Another difficulty was that our courts were not inclined to limit a claim for a product, when claims were made generally to a product made by a particular process, unless such construction appeared perfectly clear from the words of the claim. The English court, in dealing with the Swan defense, had overruled it on the ground that what Swan did was not a commercial success, but Mr. Justice Fry, in the opinion reversing Mr. Justice Kay, had said that if Swan's lamp had been a success instead of a failure, it would, in his opinion, have been an anticipation of the plaintiffs' patent. His efforts to improve his lamp had showed that he was not thinking of filamentous carbons but of other matters: still his lamp had given light for a time, and was very near, though in his opinion not quite, an anticipation. His Honor would find that the English courts had sustained the second claim of the English patent, because in their opinion it had two characteristics distinguishing it from prior lamps. One was, that the resistance of the filament was so high as to give commercial success when large numbers were used in multiple arc, and the second, that the bent carbon was a limitation, and that form must be produced by bending first and carbonizing afterward. It did not appear in the English cases that anybody had anticipated Edison on those two points.

Looking at the contention in the present case, he would next compare the evidence with the arguments of counsel. because some of the arguments were not supported by the evidence. Great stress had been laid upon Edison's appreciation of the fact that high resistance and small radiating surface were essential. Indeed, his brother Lowrey had at one time said that the making of filamentary conductors of high resistance was the whole of the invention. Now on that, which was the principal point in their case, complainants had produced two of the most striking exhibits he had ever seen. One was the exhibit of Fontaine's experiment and the other the exhibit showing the comparative sizes of conductors. The Fontaine exhibit was a problem of distribution, not a question of the use of carbon. So far as the exhibit had illustrated the advantages of high resistance, it had been entirely irrespective of the material which produced the resistance. Platinum burners would have done exactly the same. It had illustrated not only the utility of high resistance irrespective of material, but the necessity of a system of distribution by which enough current was supplied for all the lamps. The illustration of the comparative sizes of conductors required for high and low resistance lamps was a beautiful one, but it had nothing to do with the use of carbon conductors. It simply illustrated the fact that the higher the resistance the less current was needed, and hence the smaller the conducting wires might be, and in that respect no doubt high resistance in lamps was at the bottom of commercial success.

His Honor would remember that the English court sustained this patent on the ground that it was for a high resistance lamp with bent carbon. But upon the present record the complainants could not, and did not rely upon either position; they might in argument but they did not in the record. In his French patent Edison had exhausted the patentability of high resistance. It had not appeared in the English case that Edison had previously patented a high resistance lamp, and had fully explained where the difference lay between commercial success and failure. If one operative platinum lamp had been made containing the principle of high resistance and could, as the plaintiffs have alleged, have been used for the very purpose that the carbon lamps were being used, the reduction of the amount of material in the conductors, thereby giving the lamp the element of commercial utility,—it did not make any difference whether only one was made, or whether there were 50 made; it was an operative lamp.

The complainants' experts themselves have testified that high resistance was not an essential of the lamps of the present patent. Prof. Barker had said that not high total resistance, but only high specific resistance was important. Mr. Clarke had said that in his opinion the patent was not necessarily limited to lamps having a resistance high enough to make them suitable for use in multiple arc. They say that if a lamp has 10 ohms, or even five ohms, it comes within the patent. Mr. Betts then exhibited a sample case of Edison lamps, all of which were stamped with the number of the patent in suit; some of them were only half an ohm resistance. It was simply a question of size. Those with a fraction of an ohm resistance were claimed to be as much within the patent as anything else.

The idea of making carbon conductors of high resistance was obvious prior to Edison's patented invention. Mr. Clarke had admitted that in June, 1879, resistance was simply a question of where the lamp was to be used, and that anybody skilled in the art would know that was true of carbon as well as of platinum. Mr. Clarke's testimony had pointed out the only direction in which invention could have been exercised, and that was in finding some way in which a durable carbon could be made. That was all there was left in the case. Neither could complainants rely upon the other point on which the English courts had sustained the patent; the bent form of conductor; that was old, on evidence apparently not discussed before the English courts. Sawyer and Man had done it in 1878 if nobody else had done it earlier. In fact, Mr. Justice Bradley seemed to have disposed of that contention, for he had said in his opinion that it was old even before their day.

Sawyer and Man's lamps had been put aside by Mr. Justice Bradley as having been on the wrong principle; as having been low resistance lamps; and his brother Seward had devoted the morning to proving to his Honor that their lamps were low resistance lamps.

That was perfectly true, but then complainants' experts had admitted that the patent did not call for a high resistance lamp, nor for one suitable to be commercially used in multiple arc. That feature of the case had been, in the evidence, abandoned. He could hardly resist the conclusion that if the English courts had the proofs before them as in the present case there would have been nothing left of the basis on which they proceeded, and if they had sustained the claim at all it would have been on some narrower construction. Now, that was the exact state of facts that had appeared in the German case, and the consequence had been that the highest court in Germany, subsequent to all the English decisions, had held that Edison must be limited to the specific thing described; a coiled carbon incandescent conductor in which high resistance was combined with a small radiating surface by masking a part of the light. The fact was, that the only real invention that could be made when Edison took up the carbon lamp, was to show how to make a durable carbon, and this he had not described in his patent in any way which had advanced the art. (At this point the court adjourned for the day.)

THE ADAMS ELECTRIC RAILWAY CLAIMS IN SUIT.

The Adams Electric Co., of St. Louis, through Dr. Wellington Adams, whose patent and claims were lately described in THE ELECTRICAL ENGINEER, has brought suit for infringement against the Lindell Railway Co., of St. Louis, which has been using Sprague motors and apparatus. It is claimed that in these motors the principle of conveying power to the axle and the method of flexible suspension of motor and gear have been infringed. The suits will, it is understood, be defended by the Edison Co. which now owns the Sprague patents.

SHORT VS. WESTINGHOUSE ELECTRIC RAILWAY LITIGATION.

A special dispatch from St. Louis of June 19, says: "The telegraphic news this morning contains advices of an electric patent suit instituted in the United States District Court at Pittsburgh, Pa. The suit is brought by the Short Electric Railway Company, of Cleveland, Ohio, against the Westinghouse Electric and Manufacturing Company for alleged infringement of patents owned by complainants on gearless electric motors, both parties to the suit having their motors now in operation in Pittsburgh. The suit has a strong bearing on the suit brought in the United States District Court in this city only last week, and will become a phase of the same fight. The Adams Electric Company, of St. Louis, will next week ask to be made codefendant with the Westinghouse Company in the suit for infringement brought by the Short Company. It will also, at the same time, institute suit against the Short Company for infringement of a patent issued to Dr. Wellington Adams covering the gearless-motor principle.

"The officers of the Adams Company of St. Louis, claim that this action on their part is precipitated by the beginning of the Short suit. They charge that the proceedings just begun in Pittsburgh are in reality a friendly litigation between the Short and Westinghouse systems, intended to secure adjudication on certain points of their own which would materially strengthen their positions as defendants in the suit that was to have been brought by the Adams Company, following a decision in its present suit against the Sprague system. The local electric patent claimants also charge that the suit of the Short Company would never have been brought had it not been for the opening of the Adams suits in St. Louis. It is evident that a great fight over electric motor patents is just begun."

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 16, 1891.

Accumulators :—

Secondary Battery, D. Tommasi and C. Theryc, 454,091. Filed Nov. 10, 1890.
Principal feature consists in the form of the electrodes, which are tubular instead of in plate form.

Secondary Battery, J. S. Sellon, 454,187. Filed April 26, 1887.
Claims a plate or support containing an alloy of two metals and an amalgam thereof; also claims the above in combination with active material.

Alarms and Signals :—

Electric Signal for Mine Shafts, F. W. Bacorn, 454,018. Filed Sept. 2, 1890.

Signal Indicating Apparatus, J. O. Ziegler, 454,245. Filed Nov. 28, 1890.
Improvement upon the signaling apparatus patented to the same inventor Sept. 16, 1890, No. 436,371.

Conductors, Conduits and Insulators :—

Insulated Electric Conductor, E. D. McCracken, 454,060. Filed March 5, 1891.
Wraps the conductor with strips or ribbons of paper folded longitudinally so as to secure several thicknesses in one winding.

Subway for Electric Wires, W. Readman, 454,155. Filed July 26, 1891.
Forms a series of channels in the curbing along the side of the roadway or street.

Connector for Electric Wires, E. L. Nash, G. G. Stout and J. R. Davis, 454,181. Filed Jan. 20, 1891.
A tubular connector is provided with a sheath of insulating material through which pass thumb-screws with insulated handles.

Wall Fixture for Electrical Conductors, O. H. Pieper and F. M. Watson, 454,226. Filed Nov. 5, 1890.
Especially for use in securing conductors where they pass through plaster walls or similar supports.

Tubular Electric Conduit, E. H. Johnson, 454,275. Filed Sept. 15, 1890.
Two or more series of tubes are placed one over the other, always breaking joints; a cementing material is employed between the several tubes, thus making a continuous conduit.

Distribution :—

Transformer, E. Thomson, 454,090. Filed Oct. 11, 1890.
Claim 1 follows:
The combination, with a rectangular sectional core having two of its sides covered by the primary and secondary coils wound thereon, and its other sides flush with the ends of the coils, of the closed iron frames of magnetic material surrounding the core and coils and completing the magnetic circuit.

Dynamos and Motors :—

Electric Motor, H. H. Blades, 454,024. Filed May 11, 1889.
Details of design and construction intended to secure simplicity and compactness; includes means for correctly balancing the armature after it is completed and wound.

Dynamo Electric Machine, R. Eickemeyer, 454,336. Filed June 15, 1888.
A drum armature is so constructed and wound that when finished the ends of the armature are flat and substantially rectangular to the axis. The patent includes special constructions of field-magnets and of the commutator.

Electrolysis :—

Process of Electro-Deposition and Cathode Therefor, A. C. Reinfeld, 454,381. Filed Mar. 8, 1889.
For galvano-plastic deposition. The cathode or receiving surface is formed of nickel alloy, and has its surface oxidized, polished and filled with a soap-like mixture.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, W. Macmillan, 454,057. Filed Oct. 17, 1890.
Porous cup is a perforated vessel of stiff fluid-resisting paper; a covering of fibrous material is applied.

Lamps and Appurtenances :—

Incandescent-Electric-Lamp Controller, J. J. Fanning, 454,038. Filed Nov. 4, 1890.
A rheostatic apparatus for regulating the brilliancy of lamps for scenic exhibition.

Mast-arm for Electric Lamps, T. Dillon, 451,166. Filed Jan. 19, 1891.

Electric Arc Lamp, P. Clarke, 454,253. Filed Feb. 13, 1890.
Employs the expansion and contraction of a thermo conductor for actuating the regulating mechanism.

Incandescent Lamp Filament, T. A. Edison, 454,252. Filed Oct. 27, 1886.
Claims filaments formed from the hard central portions of the root of plants, especially plants of the palm family.

Electric Arc Lamp, S. W. Rushmore, 454,294. Filed Dec. 10, 1890.
Relates to the feed-regulating mechanism; employs a yielding follower upon one of the carbons.

Electric Arc Lamp, S. W. Rushmore, 454,295. Filed Feb. 16, 1891.
Relates to feed-regulating mechanism.

Electric Arc Lamp, J. E. McAuley, 454,443. Filed Apr. 21, 1890.
Details of feed-regulating mechanism.

Measurement :—

Electric Resistance Box, R. Eickemeyer, Jr., 455,207. Filed Feb. 16, 1891.
Relates to the construction of resistance boxes and particularly to the rigid and secure support of the coils and their insulation.

Electric Current Indicator, A. B. Herrick, 454,270. Filed Oct. 16, 1890.
Intended particularly for an ammeter. Employs a solenoid and movable core connected with an index hand; the solenoid is composed of several coils which can be joined up in series or in other relations by means of a commutator; the scale is marked in sections, indications at each section being appropriate for some one arrangement of the coils.

Medical and Surgical :—

Electric Apparatus for Treating Deafness, G. F. Webb, 454,313. Filed Apr. 21, 1891.
A device for applying current through the ear by means of a circular-shaped electrode.

Miscellaneous :—

Electric Switch, H. T. Clark, 454,081. Filed Apr. 15, 1891.
A rocking-lever switch.

Electric-Locked Switch, F. Teague, 454,087. Filed Dec. 15, 1890.
Adapted to insure a safely-locked connection combined with a quick break when disengaged.

Controlling Mechanism for Elevators, W. O. Wakefield, 454,095. Filed Aug. 6, 1890.
With an elevator worked by an electric motor a plunger working within a cylinder and connected with a regulator of the motor; is controlled by a valve mechanism under the hand of the attendant.

Electric Pole in Gas or Vapor Explosive Engines, F. E. Tremper and J. W. Eisenhuth, 454,238. Filed July 31, 1890.
Adjustable electrodes within the cylinder for ignition.

Apparatus for Sewing Carpets, F. Ames, 454,404. Filed Feb. 20, 1890.
Employs an electric motor mounted, with a sewing machine, upon a traveling carriage.

Method of Making Binding Posts, E. T. Greenfield. 454,430. Filed Dec. 16, 1890.

Railways and Appliances :—

Electric Railway Car, E. M. Bentley, 454,020. Filed Mar. 26, 1887.
Claim 1 follows:
The combination of the truck-frame mounted upon the axles independently of the car-springs, the electric motor supported beneath the car-body on the frame, the countershaft having substantially rigid bearings on the frame with the motor and driven by the latter, and the car-axles having substantially rigid bearings with the counter-shaft and driven therefrom by means of a connecting-rod.

Electric Motor Car, E. M. Bentley, 454,021. Filed June 13, 1888.
The motor is journaled on an axle of the truck with its armature uppermost and extending above the floor of the car-body.

Conduit for Electric Railways, E. M. Bentley, 454,022. Filed Sept. 8, 1888.
Employs for one of the slot rails of the conduit a form which may be used at the same time as one of the track rails.

Electric Railway, F. O. Blackwell, 454,023. Filed Oct. 22, 1890.
Claim 1 follows:
The combination, in an electric railway, of a supply conductor and rail-return with an accessible bare supplementary conductor connected electrically with the rails for increasing the conductivity of the return branch of the circuit, and in contact with which the travelling motor also is maintained.

Conduit for Underground or Subway Electric Systems, J. J. Miller, 454,177. Filed Feb. 14, 1891.
Details of supporters and insulators for the conductor.

Motor-Car for Underground Electric Systems, J. J. Miller, 454,178. Filed Feb. 14, 1891.

Relates to the trolley; a laterally movable slide carrying the trolley arm, which is provided with a flat guide plate to operate in the conduit slot.

Electric Head-Light, R. Pattison and D. G. Desmond, 454,184. Filed Dec. 9, 1890.

A lantern for street car head-lights.

Electric Block System for Railways, A. H. R. Guiley, 454,344. Filed Feb. 11, 1890.

The locomotive carries a pendant contact-lever adapted to engage contact-pieces along the track.

Current-Collecting Device, R. M. Hunter, 454,487. Filed Dec. 18, 1889.

The trolley arm is formed of a tube of gradually decreasing diameter.

Telegraphs :—

Electric Telegraphic Apparatus, S. V. B. Essick, 454,338. Filed Jan. 12, 1891.

A relay or receiving instrument for use with reversed currents.

Telephones and Apparatus :—

Bi-Telephone, E. J. P. Mercadier, 454,138. Filed Feb. 27, 1891.

Two receivers are made of very small weight and adapted to be carried while in use on the head of the operator, one at each ear.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

When you advertise, say something that will stick.

THE INCANDESCENT LAMP MANUFACTURERS' ASSOCIATION.

A MEETING called for the purpose of effecting an organization of incandescent lamp manufacturers was held in the Astor House, in this city, on Wednesday and Friday of last week, at which about fifteen lamp manufacturing companies were represented. A permanent organization was formed under the title given above, and the following officers were elected pro tempore: President, J. H. Cooke, Sunbeam Lamp Co.; recording secretary, O. K. Stuart, Germania Incandescent Lamp Co.; corresponding secretary, J. W. Peale, N. Y. & O. Co.; treasurer, Mr. Babcock, Buckeye Lamp Co.

Various matters connected with the trade and lamp litigation were discussed. It was agreed to give a uniform guarantee of 600 hours' average life or 100 hours for each individual lamp. It was also resolved to fix 70 cents as the price for lamps in small lots, and to scale the price down to 50 cents for large lots; sales to be made on 30 days strictly, and allowance of three cents to be made on bases returned.

The action taken at this meeting is to be confirmed at another meeting to be held at the Astor House on July 17, when it is expected that a fuller representation will be on hand. No representative of the Edison, Sawyer-Man, or Thomson-Houston Cos. was present, though it is understood that some of these will join the association later on.

THE CROWDUS CHEMICAL ELECTRIC CO.

The above company, of 230 Main street, Memphis, Tenn., operating under the patents of Mr. W. A. Crowdus in the manufacture of primary batteries for constant current and constant potential work, has now issued its catalogue and price list. It is a handsome pamphlet of 34 pages of text and illustrations, and furnishes a very full description of the apparatus brought to notice. Some of the devices have already been illustrated in the columns of THE ELECTRICAL ENGINEER. The Crowdus Co. believe that there is a very large field for primary batteries in the supply of light and power where dynamo current is not available; and instead of making any of the usual wild or absurd claims as to what they can do, they show their apparatus, give details of the cost of zinc and sulphuric acid, and give the discharging rates of each class of cell, so that any one can ascertain for himself the number of watt hours, and the cost per charge of the battery or per day. The company is supplying very neat and ingenious lamp outfits, so arranged that the lamp makes the necessary connections on being placed on the ornamental battery box, which serves as a pedestal, and which carries a charge more than equal to a full evening run. In another form the same idea is very prettily worked out in a piano lamp. The batteries and special ornamental boxes can be obtained separately, as in fact can all the various parts. In the power line, the company uses the Perret small motors of the Elektron Co., as well as one or two simple forms for turntable work for store windows. With the Perret motor and the Crowdus battery, a day's good sewing can be done, it is stated, for five cents.

A number of detail pieces, such as shades, reflectors, switches, attachments for gas fixtures, etc., are also shown, and the catalogue includes, at the end, a number of useful tables and rules for making calculations. The last page contains a summarized price list. Altogether the catalogue is one of the best, and should be in the hands of all who are interested in this class of goods.

ABOUT SLATE FOR ELECTRICAL PURPOSES.

BY

T. J. Murphy

IF the electrical industry has found new uses for mica, porcelain, lava, and other known insulators, it has certainly done wonders for the producers of slate. Formerly this article had its greatest sale for mantles, lamp bases, and wash-tubs—to say nothing of the ordinary school slate—but recent experiments show that a species of slate quarried in Vermont is among the best-known insulators, where a large area is to be covered, such as switch-boards and the like. It is even displacing hard rubber and fibre for many smaller articles on account of the various finishes which can be given to the slate, such as imitation of all the different kinds of wood, blood-stone, Tennessee marble, hard rubber—either dull or polished—the slate retaining its moisture-resisting and fire-proof properties, for which it is superior to any other material now in use.

Slate 1 inch thick weighs about 14 lbs. per square foot, and when it is of the select quality is easy to drill and tap, so that machine screws can be used. Recently a New York construction company drilled 12,000 ¼-inch holes in a piece of slate containing only 22 square feet, ⅝-inch thick. It withstood shop handling and transportation, and, considering that the holes were only ¼ of an inch apart, it speaks well for the strength of the slate.

The best slate for electrical purposes, as stated, is found in Vermont, where, probably owing to the absence of iron ore and other metals, the slate is much purer than that quarried elsewhere. Soft slate has a slight greenish color, although it is frequently found in "purple stock" and other colors.

It is found that "marbleizing" slate adds to the moisture-resisting qualities, besides giving it an artistic effect, which is greatly increased when mouldings are used in connection with it.

It has also been found that Pennsylvania slate, besides containing iron, is harder to drill, and there is consequently a more rapid wearing away of the edge of the drill, and careful tests have demonstrated that the selected Vermont slate is the best for electrical purposes. The Manhattan Building, on Wall street, is equipped with a fine slate switch-board built by the Eureka Electric Co., who have also furnished one to the Gerlach Apartment House, on West 27th street. The American Bell Telephone Building in Boston has recently added a slate switch-board, built by the Western Electric Co., and the Manhattan Electric Co. have positioned an incandescent switch-board in their 80th street and Avenue B station, the board being built by V. Prentis, 303 Kent Avenue, Brooklyn. This gentleman formerly used Pennsylvania slate, but found it so expensive on account of the cost of drilling that he thought to make a change, and secured some Vermont slate from me, and found that he could drill the slate in about one-half the time, besides testing up better. I am now constructing a switch-board 13 feet long, 73 inches high, made in six pieces, for the Electrical Construction and Supply Co. of this city, to be used in a plant now erecting for the H. B. Claflin & Co. Building.

Where switch-boards are made in sections it is well to make a drawing or give the exact dimensions, and indicate where screw-holes are to be, so that the switch-board can be drilled before marbleizing, although it can be drilled afterwards if care is taken to start the drill on the marbleized side, for if drilled in from the back the finish is liable to be cracked off, very much like a veneer.

After slate has been quarried and sawed into marketable thickness, which is generally about 1 inch, it is "flowed"—*i.e.*; a composition paint is poured over the surface. It is then put in a kiln or heating oven and kept for several hours at a temperature of about 150 degrees. If it is to be of a higher finish a second coat is given to it, and it is again baked the same as before. It is then rubbed with fine pumice stone until a smooth surface is had, after which a coat of fine varnish is applied and it is baked once more. In fact, the finishing of it is very much similar to the finish given piano cases, only, of course, not so highly polished. The slate can be beveled or any of the ordinary forms of moulding can be given to the edge. Frequently a separate moulding of a different finish is placed around the board to frame it.

In order that those not familiar with the finish, quality, and working properties of slate may be informed, I will furnish to any of your readers who are interested a sample of both plain and marbleized slate, and should any special finish be desired I will furnish a sample of flowed black, polished black, dull black, flowed marbleized, polished marbleized, and plain slate, the six pieces of any size under 12 inches square, 1 inch thick, for $1.50, or 50 cents for any one piece. As the slate is used for transformers, fuses, resistance coils, bases for knife switches, rheostat heads, terminal boards, washers, &c., &c., it will be seen that different finishes are very desirable.

SOME NEW RAILWAY SPECIALTIES OF THE ILLINOIS ELECTRIC MATERIAL CO.

We call the attention of the electric railway public to a new trolley-bell hanger clip, as illustrated in Fig. 1. The many superior points of this clip will be seen at a glance. In the first place the two portions of the clip make a perfect hinge of themselves, doing away with the shaft or rivet, which is a weak point. No solder or screws are used.

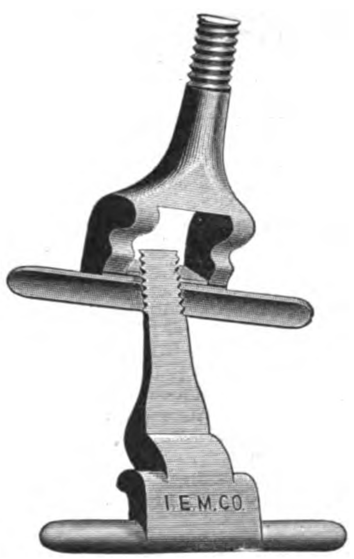

FIG. 1.—NEW TROLLEY-BELL HANGER CLIP.

Fig. 2 illustrates the several parts showing the interior of the hard rubber bell. A heavy bushing is used. All the metal work is of the best heavy red brass. Fig. 3 shows the hanger complete, making a trolley-bell clip that combines not only beauty and strength, but a saving of time and labor in line construction, with a price that is within the reach of all.

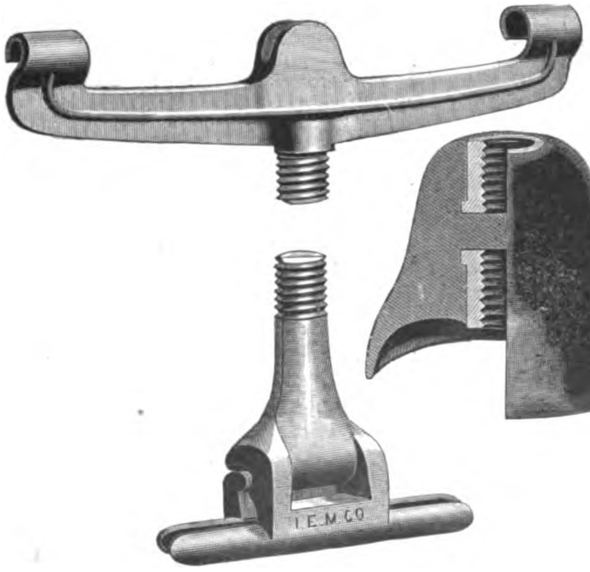

FIG. 2.—NEW TROLLEY-BELL HANGER CLIP.

The hanger is sold exclusively by the Illinois Electric Material Company, 158 Fifth Avenue, Chicago, Illinois.

MR. FRANK H. PUTNEY, president of the Waukesha Electric Light Co., Waukesha, Wis., was in Chicago last week for a short visit.

THE HUBBELL IMPROVED PRIMARY BATTERY.

The dynamo driven by steam or water power shows such economy as compared with the cost of generating current by means of primary batteries that those who pretend to be able to produce current on a large scale for all purposes, by means of primary batteries consuming zinc, are either deceiving themselves or designedly attempting a fraud on the public. But it cannot be denied that even for the production of current for electric lighting and power, there are many situations where a primary battery possesses advantages which make its use not only economical but convenient. Thus, for the operation of light machinery, such as sewing machines, dental lathes, small pleasure boats, and for lighting small lamps in places where other forms of generators would be inapplicable, the primary battery may still find effective employment. It is with a full understanding of the limits within which such a battery can be profitably employed that Capt C. J. Hubbell, of this city has designed a cell embodying several excellent features.

One type of Capt. Hubbell's battery consists of an acid proof box 12"x6"x6", divided into 8 cells. The elements used are zinc and carbon, the latter being cylindrical in form $\frac{1}{16}$ of an inch thick with a split on one side to permit of a free circulation of the liquid. The centre of the bottom of the carbon is projected into an insulated socket having a metal lining terminating in a screw which projects through a hole in the bottom of the porous cup and cell, and is rendered absolutely water tight by means of rubber washers and screws which also hold them firmly in position.

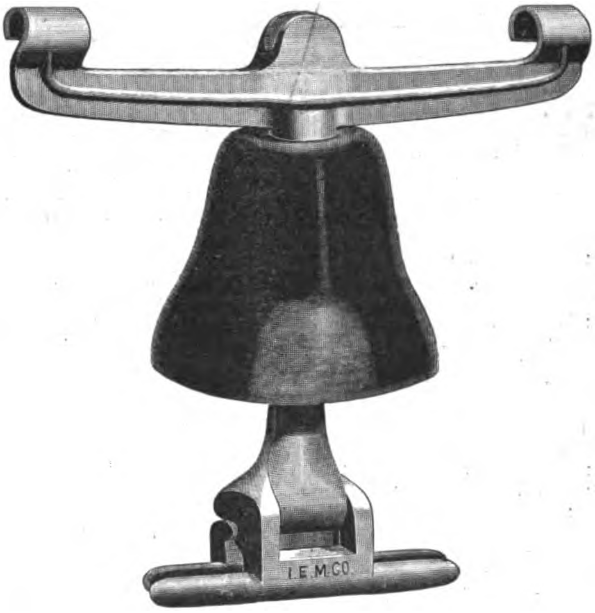

FIG. 3.—NEW TROLLEY-BELL HANGER CLIP.

The method Capt. Hubbell adopts for attaching the electrode to the zinc element is termed a "central contact"; by this method of connection he claims to secure a greater percentage of the energy of the zinc, and absolute freedom from local action. The zinc electrode is also brought through the bottom of the box and secured by washer and screw. The connections are easily and rapidly made either in series or multiple by the use of a small switch-board on one side of the box. The cell also embodies two other important qualities, namely, the oxydizing of noxious fumes produced when the battery is in action, and the cutting off of communication between the two liquids to prevent their mixture, which generally occurs in a two fluid battery, when allowed to remain inactive. It is thus possible to use the battery from day to day, without recharging, until it is exhausted, thereby greatly increasing its commercial value. The first object above mentioned, is accomplished by attaching to the under side of the lid a pad or porus sack filled with asbestos fibre or mineral wool and saturated with bichromate of potash.

Attached to this lid or pad are a series of tubes of insulating material which fit over the porous cups when the cover is depressed and which entirely enclose the cups. This absolutely prevents any local action when the battery is not in use, as no mixture of the liquids can take place. This is readily accomplished by the use of a lazy chain on either side and a tube at either end of the outside of the box through which a rod slips up and down. It should be mentioned that the electrode or arm by which the zinc element is connected in the liquid is of zinc amalgamated with a special amalgam which, while not destroying its conductivity, prevents any local action of the liquid upon it.

The zinc element being cylindrical in form and fitting closely around the porous cup—only space enough being left to admit of the shields or tubes passing between them—and the carbon being also cylindrical and placed close to the inner surface of the porous cup, the advantage of both a large depolarizing surface of carbon, and large surface of zinc, giving a large amperage with low resistance in a small space.

Another mechanical feature of this battery is the manner in which the box is constructed so as to prevent slopping The partitions forming the cells are made some two inches below the top, or, in other words, the box extends two inches above them, thus leaving a space into which the pad or sack fits when depressed, thereby rendering it perfectly fluid-tight during transportation. As this type of the battery is intended to be portable, weighing only about 15 pounds when charged, it is an important improvement.

Perhaps one of the most useful and important applications of the battery is a small four cell battery weighing but 4½ pounds when charged, and which will maintain for a period of 12 hours a three c. p. lamp to full incandescence at a cost of 1¼ cents for the entire period. Capt. Hubbell has two types of this size, one square in form, with the lamp in a reflector on its side, and protected by a thick glass. The other type is made to conform to the shape of the back of the wearer, a conducting flexible cord connecting the battery to a protected lamp attached to a miner's hat; the dimensions of this battery are two in. wide, seven in. from point to point, six in. in depth, and it weighs the same as the other, 4½ pounds.

THOMSON-HOUSTON PLANTS.

The Thomson-Houston Electric Company reports the sale of the following arc apparatus: Athena, O., 18; Braintree, Mass., 30; Chehalis, Wash., 30; Bridgeport, Conn., 45; Portland, Me., 45; Brooklyn, N. Y., 90; Narragansett Pier, R. I., 30; Harrison, O., 35; Ashland, O., 70; Findlay, O., 45; Springfield, Vt., 35; Anderson, Ind., 50; Salem, Va., 100: Athol, Mass., 25; Poughkeepsie, N. Y., 50; Beverely, Mass., 100; No. Tonawanda, N. Y., 100; Lancaster, O., 50. Corning, N. Y., 50; Camden, N. J., 50; Lexington, Ky., 50; Catlettsburgh, Ky., 50; Lockport, N. Y.. 50; Noblesville, Ind., 50; Clinton, Ia.. 50; Parkersburg, W. Va., 100; Lincoln, Neb., 150; Washington, D. C., 100; Put-In-Bay, O., 50; Bay City, Mich., 100; Syracuse, N. Y.. 50; Newton, Mass., 50: Columbus, O., 50; Covington, Ky., 50; Newark, N. J., 100; Elwood, Md., 50; Key West, Fla.. 50; Oakland, Cal., 50. Incandescent Apparatus: Narragansett Pier, R. I., 1,300; Springfield, Vt., 650; Salem, Va., 1,300; Newton. Mass., 650; Key West, Fla., 1,950; Titusville, Fla., 400; New Haven, Conn., 400; Bay Shore, L. I., 400; Dunellen, N. J., 300; Shawnee, O., 300; Akron, O., 1,300; Camden, N. J., 1,300; Brooklyn. N. Y., 1.300; Lock Haven, Pa., 1,300; Iron Mountain. Mich.. 1,950; Buena Vista, W. Va.. 1,300; Norwalk, Conn., 1,300; Lexington, K., 1,300; Atlanta, Ga., 1,300; Waltham, Mass., 1,300; Tacoma, Wash.. 2,600; Morristown, Tenn., 650; White River Junction, Vt., 650; New London, Conn., 650; Patchogue, L. I., 650; Martinville, Md.. 650; Princeton, Md., 650; Bedford City, Va., 650; Millersby, O., 650; Milton, Mass., 650; Cohassett. Mass.. 650; Catlettsburg, Ky., 650; Wacco, Texas, 1,950. Isolated Plants, arc apparatus: Aluminum Carbon Co., Lancaster, Pa., 6; U. S. Immigration Depot, Ellis, Is.. N. Y. Harbor, 40; Palisades Amusement Co., 150. Isolated Plants, Incandescent Apparatus: H. K. Hartzell, Calassugua, Pa. 50; Fort Hamilton Brew. Co., Fort Hamilton, N. Y., 50, Bradbury-Stone Storage Battery Co., Lowell, Mass., 100; National Transit Co., Parkers Bdg., N. Y., 100; N. Copeland. New York, 100; Henry Adams, Rockville, Conn., 150; Cutler Bros., Wakefield, Mass. 150; Blue Ridge Inn, Mt. Airy, No. Carolina, 200; Wainright Real Estate Co., St. Louis, Mo., 2,000; Agnes Scott Institute, Decatur, Ga., 200; Croton Magnetic Iron Mine, Brewster, N. Y., 300; H. C. F. Koch, New York, 800; W. Engle & Co., Orono, Maine, 50; Cleveland Ship Building Co., Cleveland, O., 100; Consumers' Brewery Co.. New York, 400; Manf. Investment Co., Madison, Me., 400; A. O. Couch, New York, 200; W. E. Anderson, Blacksburg, Va., 400; Washington Loan and Trust Co., Washington, D. C., 300.

ELECTRICAL INDUSTRIES IN NEW ENGLAND.

At present there is a decided movement in New England in the direction of utilizing water powers for the generating and transmitting of electrical force over long distances. Such has been the progress in this direction during the last few years that the largest electrical companies in the country are now prepared to utilize some of the hitherto unused water power for the propelling of machinery, for lighting, and for street railway work in the large cities of New England.

Prominent among these enterprises is the development of a large water power on the Merrimac river, situated in the city of Concord, the capital of New Hampshire. When the dam is completed the company developing this property will have a large and steady power, possessing a reservoir extending up stream 18 miles, and reinforced by numerous ponds and lakes, including Lake Winnipiseogee, which are provided with dams by which surplus water is received during the flood seasons. Thus will the power not only be ample, but it will be steady.

It is proposed to furnish electricity over three circuits, and perhaps a fourth, to the present thickly settled portion of the city of Concord, as the distance to the dam is 4 miles north from the State House. One circuit will be used for the transmission of power, one for arc lighting, and the third for incandescent lighting.

This property, being situated within the city of Concord, will also be used for another purpose, namely, the location of manufacturing industries, both large and small, some driven by water taken from the canal and some by electricity.

The company developing this power possesses not only the water power with all its franchises, but a large tract of land, very favorably divided for mill site and resident purposes. It is said that there is no finer property in the country than this, and being situated only 75 miles from Boston, to and from which several express trains pass every day, thus allowing parties to do business in both cities upon the same day, it is certain that any power not wanted for electrical work will be in ready demand by manufacturers. This is especially true since it is the policy of the city of Concord to exempt from taxation for a period of 10 years any manufacturing property that shall locate there, while the company owning the land and power offer special inducements with reference to both.

The property is known as Sewalls Falls, and is owned by the Concord Land and Water Power Co., of which Geo. F. Page, president of the celebrated Page Belting Co., is the president and general manager. This affords a fine opportunity for manufacturers of electrical apparatus to secure favorable location for their business, as also any other manufacturers who may be looking for a location where the largest inducements can be offered and the best results attained, because not only are to be had the advantages which are enumerated, but Concord is especially favored with an abundance of the best of cheap labor, a very important item in manufacturing business.

ENGINEERING EQUIPMENT CO.

Mr. F. A. Magee, M. E., who located himself recently at 126 Pearl Street, Boston, Mass., in the interests of the Engineering Equipment Company and the Underwood Mfg. Co., says that business is good and prospects are excellent for the rapid growth of trade in Cotton Leather Belting, Dodge "Independence" Wood Split Pulleys, Anderson Electric Railway Appliances, especially the "Boston" Trolley, and in the other specialties controlled by the Engineering Equipment Company. Mr. Magee is an engineer of this company and is manager of the Boston office.

Mr. W. F. D. Crane, M. E., who became associated on June 1, with the Engineering Equipment Company, is one of the engineers of the company, at their New York offices, 143 Liberty street, and is in charge principally of the railroad business which is coming to that company increasingly. Mr. Crane reports excellent business on the new Kellogg steel poles, the indurated fibre pipe for subways, and other materials and appliances for electric railways, such as the Anderson goods, notably the "Boston" trolley.

Particular attention of readers is called to the announcement in this issue of the new Kellogg steel poles for electric railways. These poles are already in such demand that orders to come cannot be filled promptly unless they are received two weeks in advance of shipping dates by the sole selling agents, the Engineering Equipment Company, 143 Liberty street, New York; 126 Pearl street, Boston.

THE BAIN ELECTRIC MANUFACTURING CO.

The above named company, of Chicago, are now building alternating current dynamos for long-distance incandescent lighting. These machines have been designed by Mr. Foree Bain, president and electrical engineer of the company, and have many novel and advantageous features, being self-exciting and also self-regulating, the armature coils being wound in separate sets and in a special manner to secure these results. Mr. Bain has also designed some complete small isolated plant outfits for residences, small buildings, factories, etc. They comprise dynamo machine, lamps, sockets all ready wired, wire, cleats and all necessary accessories, and a diagram and complete instructions for setting up, and are built for 10, 15 or 20 lights.

There has long been a need for such an equipment, and the Bain Electric Manufacturing Co. are now prepared to supply this demand.

The prices for these are also quite reasonable, and any one desiring such an outfit would do well to investigate their merits.

THE ELECTRICAL FIBER CARBON CO.

The above company are fitting up their new and spacious factory, at 1234 to 1236 Michigan avenue, with all the necessary machinery and apparatus for the manufacture of carbon of all kinds for electrical purposes. They are also placing on the market a new carbon battery, which is of highly novel construction and possesses in a marked degree all the requirements of a perfect open-circuit battery. The objectionable feature of "creeping" has been entirely overcome, and the battery combines durability and lightness and will fill a long-felt want. They have installed calciners and ovens capable of handling a very large output, and also hydraulic and grinding machinery specially designed for the production of carbons of all sizes and shapes. The company can make anything in the carbon line and of larger size and more intricate form than has heretofore been practicable. They have perfected their processes so as to produce from the raw material employed carbon articles of varied homogeneity and of any desired resistance.

Associated with the concern is an expert chemist, Mr. Eugene Klein, who is also secretary and treasurer, and who will look after the many chemical processes which it is necessary to employ. Mr. John H. Davis, the vice-president, is one of the pioneers in the carbon industry and understands the manipulation of carbon in all its details. Mr. John R. Markel, who is one of the best-known men in the electrical business, from his long connection with lighting work and the supply trade, is the president, and will look after the selling of the goods. He will shortly take an extended trip to all the large cities and electrical centres, and the merits of their products will certainly be appreciated by the electrical fraternity all over the country.

STEPHENSON CAR WORKS TO BE MOVED.

The John Stephenson Company, car builders, has purchased the property known as the Birnie Farm, between Larchmont and Mamaroneck, on the New-Haven Railroad, and will erect extensive car-works on it. The property comprises about thirty-five acres. It is the intention of the company to begin at once to prepare the ground for the erection of the buildings. The new works will probably be the largest and finest in the country. The business has increased so much lately that the present quarters in Twenty-seventh street, which occupy eleven city lots, have become far too limited and a change was found necessary to enable the company to enlarge its facilities. Larger cars, especially larger electric cars, are demanded, and in the new factory special arrangements will be made to build these. The company will retain its valuable property in Twenty-seventh street for the present. It expects to have the new factory in working order inside of two years.

THE CROSBY ELECRIC COMPANY.

The Crosby Electric Company, having announced to its creditors its inability to meet its obligations, a meeting of creditors was held at the company's office Saturday, June 13. A statement of assets and liabilities was presented showing about $10,000 on each side of the account. The company offered in settlement, and with a view of continuing their business, 50 per cent. of claims in stock of the company and 50 per cent. in three notes at 12, 18 and 24 months respectively. A committee of creditors was appointed to consider the proposition. A further meeting of creditors was had June 17th, when the committee reported. They advised against acceptance of the company's offer, and by a vote of creditors present, covering about three-fourths of the claims, the company was required to make a voluntary dissolution. The results of the company's business to June 1, as submitted by the committee in a report by an expert accountant, did not, in the opinion of the heaviest creditors present, justify measures looking to a continuance of the business.

MR. DAVID E. EVANS.

It was once said that Mr. "Dave" Evans was the only "live" electric light superintendent in the South, and though he now has plenty of company in the front ranks of the industry there, his energy is as striking as ever. For some little while to come he will maintain his connection with the Baxter Motor Co. in Baltimore, but he is now going directly into the motor business and will make a specialty of it. He will pay particular attention to electric railway work, and has already been given the contract for construction and track-laying of the North Avenue Electric Railway, in Baltimore. Our long friendship with Mr. Evans and our warm admiration of the many sterling qualities that have made him so valuable in every capacity in this his adopted country compel us to wish for him every manner of success in his new field.

C. & C. FAN AND VENTILATING OUTFITS.

Several nickel-plated C. & C. fan outfits have recently been installed in the White House, at Washington. Large ventilating exhaust fans with C. & C. motors connected directly to the fan shafts have been running for several months past in the Pennsylvania State Capitol Building, at Harrisburg, one in the Assembly and one in the Senate Chamber. The members have been most enthusiastic over the success of the machines, and have passed resolutions testifying to the great improvement the outfits have effected in the atmosphere of the room. The White Star steamship "City of New York," has been equipped with C. & C. fan outfits with 18-inch fans. The Edison Electric Illuminating Co. of New York, bought one hundred C. & C. fan outfits last week. The new operating room in the City Hospital, Rochester, N. Y., is ventilated by a C. & C. exhaust electric fan combination with fan thirty-six inches in diameter.

IN PRAISE OF THE BALL ENGINE.

The Ball Engine Co., of Erie, Pa., have received the following from Mr. C. G. Lyman, secretary of the Queen City Electric Light Co., of Cincinnati, O.: "Replying to your favor of the 27th of February, regarding the Ball engines we have in use, we have one 100 h. p. and two 150 h. p. Ball engines; all three of them are run under exceedingly trying circumstances for any engine. The smallest one has been in use now nearly two years; one of the larger ones about 18 months, and the other one a year, and when we consider the circumstances that two of these engines have to run alongside of the boilers in the fire room, being exposed to the dust and ashes from the same, it is remarkable that we have not had a great deal of trouble with them. But we are pleased to say that they have always done their duty in a highly satisfactory manner, and we look upon the Ball as one of the best high-speed engines."

THE CARD ELECTRIC MOTOR AND DYNAMO CO.

The above concern, of Cincinnati, O., under date of May, have issued a very pretty and tasteful catalogue of their light and power apparatus, which from time to time has been illustrated in our columns. It includes their excellent constant potential machines of the "A" type, as well as of the constant potential and constant current, type "C.," and details are shown, such as the armature, ball bearings, and adjustable self-oiler, their self-oiling bearings, rheostat, etc. Views are also given of their constant current, type "B," motor, not only in full perspective but in clear outline, showing up the governing mechanism, by means of which the motor takes current in strict proportion to the load. Another cut shows the company's one-sixth h. p. motor and fan. A page is also devoted to the Ward arc lamp, which they furnish with their dynamos for incandescent isolated plants.

CONDUIT WIRING CO.

Mr. C. J. Klein, the general manager of this company, 12 West Twenty-ninth street, informs us that they are very busy with their new contracts for wiring with the "Interior Conduit" system. They now have several contracts for houses at Greenwich, Conn.; for St. Bernard's Church, this city, and for a large New York residence, as well as the big Temple Emanuel, which will take 200 lights including fixtures. They also have two buildings to conduit on One Hundred and Twenty-fifth street.

CLAY, PEPPER & REGISTER.

The above electrical engineering concern, of the Provident Building, Philadelphia, are now in the field, although at present only for limited orders, to supply small dynamos and motors—that is to say, machines ranging from one-eighth up to ten horse-power. They have already placed several of their motors on circuits near Philadelphia, and are in receipt of most favorable and encouraging reports. These motors are designed for slow speed.

KERITE CABLES.

Mr. G. B. Prescott, Jr., agent for Day's Kerite, reports the laying of an 18 conductor cable, built to special specification, across the North River, for the American Long Distance Telephone Co. He has also made a contract with the Western Union Tel. Co. for a 10 conductor cable to be laid in the North River. The demand for the Kerite specialties pursues the even tenor of its way.

THE ROCKY MOUNTAIN ELECTRIC LIGHT AND SUPPLY CO.

The Rocky Mountain Electric Light and Supply Company has been organized with a capital stock of $50,000. The incorporators are Harry C. Kessler, John O'Rourke, William Owsley, M. L. Holland, Frank Shaw, John A. Tupper and S. W. Graves. The last named is secretary of the company. The object for which the organization was formed is to carry on the business of merchandizing electrical supplies, of which the company propose to carry a large stock. The offices of the company are in Butte City. Mr. J. A. Tupper, of this company, was formerly manager of the Butte Electric Light Co.

THE BRAZELLE GOVERNOR.

The Mid-Continent Manufacturing Co., of St. Louis, Mo., are installing quite a number of their well-known Brazelle governors on slide-valve engines. This is a most effective device to cause any slide-valve engine to run at a constant speed, irrespective of variation in load, and is especially adapted for use in isolated plants and stations, where engines are employed which are not governed within a small per cent. This governor is an automatic hydraulic governor, and those in need of a good governor should investigate its merits.

NEW YORK NOTES.

The Trenton, N. J., China Co., are arranging to carry on their business as usual, but on a much more substantial financial basis than ever before. Their orders for electrical porcelain have continued to be large, and they have been very successful in that line.

Mr. T. J. Murphy, of 96 Columbus avenue, this city, contributes a very interesting article on the use of slate for electrical purposes. Mr. Murphy is very busily engaged supplying the market with various slate specialties for electrical uses, such as switchboards, &c.

BUFFALO NOTES.

The Short Electric Railway Co. have been awarded the contract for the electrical equipment of the Dunkirk & Fredonia R. R. Co., and the work of rebuilding the line was commenced upon the 11th inst.

The Field Engineering Co. have completed the Niagara street line of the Buffalo Street Railawy, and cars will commence running on the 18th. The apparatus at the power station has been in operation during the past week, and is in perfect order. Thirty-four-foot vestibuled cars built by the Gilbert Manufacturing Co., each equipped with two 15 h. p. "S. R. G." Thomson-Houston motors, will be used on this line.

Mr. Frank Drake.—Cards are out for the marriage of Mr. Frank Drake, electrical engineer of the Pittsburgh and Birmingham Traction Co., Pittsburgh, Pa., to Miss Luella Love, of Buffalo, N. Y., on the 24th inst. Mr. Drake was formerly engineer for the Buffalo Street R. R. Co.

WESTERN TRADE NOTES.

Kohler Bros. & Grier are doing a phenomenal business with the famous Eddy motors, for which they are the Western agents. Among the recent motors, they have installed two 2 h. p., three 3 h. p., one 5 h. p., one 15 h. p. and one 5 h. p. They have also sold a 50 h. p. generator.

Prof. Francis B. Crocker was a Chicago visitor last week.

Mr. S. F. B. Morse, representing the Loomis system, was in Chicago last week, and with Mr. Frederick L. Merrill, Western agent, called at the office of The Electrical Engineer.

S. D. Childs & Co., the engravers and medalists of Chicago, have brought out a very handsome souvenir in the shape of an aluminum medal, one of which they have presented to the Western office of The Electrical Engineer. It is the size of a silver dollar, one face representing the General Grant monument to be erected in Lincoln Park this fall. It is a very beautiful piece of workmanship and forms a handsome souvenir.

The Western Electric Co. have among other recent orders secured contracts in Pittsburgh for the new Alvin Theatre, owned by Charles L. Davis, 2,000 lights; the new Telephone Building, 700 lights; the Howard Glass Works, 800 lights; the Pittsburgh *Despatch* building, 400 lights. All these contracts were secured by Mr. Edward L. Devore, the energetic representative of the Western Electric Co., with headquarters in Pittsburgh. Although Mr. Devore has only been engaged in electric work for a short period, he has made a most remarkable record in the large volume of business he has obtained.

Cutter's Magnetic Cut-out, which we illustrated last week, seems to be just the thing for electric railways, as it saves the constant burning out of armature and field coils. Mr. George Cutter is adapting it to various other uses, and his shop force has been increased to turn out these magnetic cut-outs and his other specialties.

The Ball Engine Co., of Erie, Pa., have received the following from the Naugatuck, Conn., Electric Light Co.: "Your favor of the 21st inst. received, and beg leave to say that we have used one of your 60 h. p. engines for over four years, with entire satisfaction, and are so pleased with its operations, that we are now erecting a 200 horse power cross compound engine of your manufacture."

ST. LOUIS TRADE NOTES.

The Columbia Incandescent Lamp Co. are experiencing a brisk demand for Columbia incandescents, which are giving good satisfaction on account of their long life, small absorption of current, and freedom from discoloration.

The Wagner Electric Mfg. Co., whose alternating fan motor was recently illustrated in the columns of The Electrical Engineer, are finding a ready market for their motors. They will shortly place on the the market some larger sized alternating motors for all kinds of power work.

The St. Louis Electrical Co. have just been awarded a contract for the complete wiring equipment and all the fixtures for the electric light plant in the Third National Bank, and have also secured a similar contract from the Chemical National Bank. In supplies of all kinds they are doing a large and prosperous business.

The Southern Electrical Supply Co. have just completed their new offices, which add much to the attractive appearance of their handsome store. The partitions are all of highly polished cherry wood, with French plate-glass windows. Mr. W. C. McKinlock, manager of the company, reports business as flourishing, and the outlook for the future as of the most encouraging nature.

Mr. Julius Lefmann, 309 Fagin Building, St. Louis, handles a very complete line of street railway specialties of new and valuable designs. Street railway men should look into their merits.

The Emerson Electric Mfg. Co. are almost snowed under with orders for their new alternating fan motors. Central stations operating the alternating system are sending in orders from all parts of the country for these motors, which are connected direct in the lamp circuit, and operate as perfectly as any direct current motor.

The American Electrical Mfg. Co. are very busy manufacturing American incandescent lamps, which have been giving excellent satisfaction wherever they have been used.

The Stevenson-Hoggson Electric Co. are having quite a run on their single-magnet bells, which are excellent in design and workmanship.

The Western Electrical Supply Co. have now got comfortably settled in their handsome new store on Locust and Sixth streets. They will carry a large stock of high-class supplies and goods, and be prepared to fill orders at short notice.

The Shultz Belting Co. have some very large orders for their belts on hand for various parts of this country and also for Europe, where they have a large and growing trade. They are meeting with excellent success with their link belting, which is especially suited for street railway work.

The Sunbeam Incandescent Lamp Co. have been recently shipping a large number of their well-known lamps to British Columbia, Mew Mexico, California, and Panama.

The St. Louis and Suburban Railroad Co., who operate a line 28 miles in length, composed of about 4 miles of cable and 24 miles of narrow gauge steam road, have determined to adopt electric power for the entire line. An entirely new equipment of rolling stock, consisting of 60 Thomson-Houston motor cars, and 60 trail cars, will take the place of the old cable and steam equipment. The cable engines will be transferred to the new electric power house at De Hodiament station and used to drive the generators.

L. L. Somers, assistant electrician of the Western Union Telegraph Co., Chicago, is in charge of the installation of the electrical plant of the new W. U. Telegraph building, St. Louis. The plant will be complete in a few weeks, and will be a model of excellence in modern telegraph engineering. It has been described in The Electrical Engineer.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.